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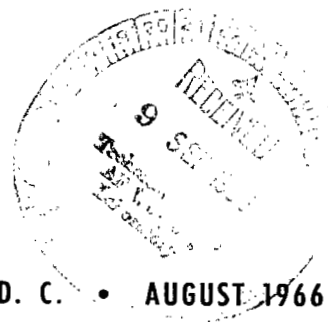
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**DIRECT CALCULATION OF SPECIFIC HEATS
AND RELATED THERMODYNAMIC PROPERTIES
OF ARBITRARY GAS MIXTURES
WITH TABULATED RESULTS**

by Perry A. Newman and Dennis O. Allison

Langley Research Center

Langley Station, Hampton, Va.



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SUMMARY

It is shown that the partial derivatives of the species concentrations can be computed using the same matrix of coefficients as that used in the free-energy minimization iterations to determine the equilibrium concentrations. The second-order thermodynamic properties directly computed from these derivatives agree very well with existing properties (both directly and numerically obtained) for air considered as a mixture of ideal gases. Comparison of these results with recent imperfect air results shows that the "mixture of ideal gases approximation" produces acceptable engineering data (error less than 5 percent) for temperatures $\leq 15\,000^{\circ}\text{K}$ and pressures $\leq 10^2$ atmospheres. Tabulated results for the high-temperature thermodynamic properties of NASA engineering model Mars atmosphere 3 are given for 36 pressures at each of 56 temperatures.

INTRODUCTION

During the past ten years, many reports have been published on the calculation of high-temperature thermodynamic properties of gas mixtures. A number of these works for dry air have been reviewed by Hochstim (ref. 1) and he states that the thermodynamic properties of references 2 to 8 agree within about 1 percent. Many compilations cited in reference 1 do not include the specific heats and related thermodynamic derivatives and generally those that do either used numerical interpolation and differentiation or simplified the air model. Two exceptions are: Logan and Treanor (ref. 6) who directly calculated all quantities from the partition function and its derivatives, and Hochstim and Adams (ref. 9) who describe a closed-form solution for the first partial derivatives of the species concentrations which requires the species internal energies, heats of formation, and concentrations to be given. Since reference 1 appeared, Browne (ref. 10) has published air data where the equilibrium isentropic exponent has been computed directly; other derivatives, however, are not given. With the exception of several points computed by Gilmore (ref. 3), the tabulated properties are those for air which is treated as a

mixture of ideal gases. Results of a more recent calculation by Hilsenrath and Klein for imperfect air (that is, a mixture of imperfect gases) are given in references 11 and 12. Specific heats and related derivatives for these data were computed by Lewis and Neel (ref. 13) by using the "spline-fit" procedure of Landis and Nilson (ref. 14). Combustion product gases or propellants have also received much attention in the past. References 15 and 16 describe general computer programs and cite other works in this area.

Current mission analyses for flight near other planets require high-temperature thermodynamic properties of the respective atmosphere. Some properties for several of the earlier proposed atmospheres are given in references 17 and 18, for example. Of the many atmospheres that have been proposed, NASA has chosen three tentative engineering models of the Mars atmosphere (ref. 19) specifically for use in mission analyses. As is pointed out in reference 19, these models are to be revised as more definitive measurements are made. Very recently, Bailey (ref. 20) prepared Mollier diagrams covering a wide temperature-density range for all three NASA engineering model Mars atmospheres. However, as he points out, the assumptions which were made were not uniformly valid over the entire temperature-density range, and no indication is given as to the size of errors that are to be expected.

In the present paper, the gas is assumed to be a mixture of ideal gases and the specific heats and related derivatives have been computed directly from the composition partial derivatives and second-derivatives of the partition functions. The Mayer and Mayer (ref. 21) approach for calculating the partition functions of diatoms has been modified. This modification is discussed in appendix E of reference 22 and in reference 23. The equilibrium composition is determined by minimizing the Gibbs free energy with the White method (ref. 24). It has been shown by Zeleznik and Gordon (ref. 25) that this method and two other widely used general computational methods all converge and are essentially equivalent. Properties for air have been computed in order to show, through comparison with other works, the temperature-pressure range in which properties for other atmospheres should be accurate to about 1 percent or less. The air results are not intended to be as accurate as the more comprehensive results for imperfect air, such as those of references 11 and 12.

Tabulated results for NASA engineering Mars atmosphere model 3 are presented. This model is the "minimum" model of reference 19: 60% CO₂, 40% N₂ by mass. (It has the lowest surface pressure, 10 mb (10³N/m²), and is therefore most like the current estimates.) An accurate comparison of these results with those of Bailey (ref. 20) cannot be made since the pressure corresponding to his independent variables (temperature, density) cannot be read well enough from the diagrams. The present program uses temperature and pressure as independent variables. Several graphical "spot checks" have been made on the species compositions at 6000° K and 9000° K. Since the data required

(from ref. 20) to compute a single comparison point had to be read from three different plots, these checks are only approximate. The isentropic exponent, a second-order thermodynamic property, is also compared and some differences are noted.

SYMBOLS

A	equilibrium sound speed
a_{ik}	number of atoms of component k per particle of species i
b_k	number of moles of component k per mass of mixture (eq. (7))
C_p	heat capacity at constant pressure per mole of undissociated mixture
$C_{p,i}$	heat capacity at constant pressure per mole of species i
C_v	heat capacity at constant volume per mole of undissociated mixture
F	Gibbs free energy of mixture per mole of undissociated mixture
f_i	Gibbs free energy per mole of species i
H	enthalpy of mixture per mole of undissociated mixture
h_i	enthalpy per mole of species i
h_{oi}	standard heat of formation per mole of species i at $T = 0^\circ \text{K}$
i	index for species
k, k'	indices for components
m	total number of components in mixture
M_u	molecular weight of undissociated mixture
n	total number of species considered
N_e	electron number density, particles/cm ³

p	pressure
Q_i	partition function of species i at $p = p_0$
R	universal gas constant
r_k	Lagrange multiplier for mass constraint of component k
S	entropy of mixture per mole of undissociated mixture
T	temperature
V	volume per mole of undissociated mixture, M_u/ρ
y_i	number of moles of species i per mass of mixture
$\bar{y} = \sum_{i=1}^n y_i$	
Z	molecular weight ratio, $M_u \bar{y}$
γ	specific heat ratio, $\frac{C_P}{C_V}$
γ_E	isentropic exponent, $\left(\frac{\partial \log_e p}{\partial \log_e \rho} \right)_S$
ρ	mass density

Subscripts:

$j = 1$ for determining $\left(\frac{\partial y_i}{\partial p} \right)_T$

$j = 2$ for determining $\left(\frac{\partial y_i}{\partial T} \right)_p$

p constant pressure

S constant entropy

T constant temperature

o reference condition

Standard chemical symbols are used for the species designation. Note that the mixture properties C_p , C_v , F , H , S , and V are per mole of undissociated mixture. In order to obtain the corresponding properties per mass of mixture, divide by M_u , a constant for a given mixture.

METHOD

The basic assumptions, description of the method, and a list of input constants used in the determination of the equilibrium composition and first-order thermodynamic properties (those independent of the composition partial derivatives) are given in references 22 and 23. Some comments on the first-order property calculations are made in the next section followed by a description of the method used to compute the second-order properties.

First-Order Properties

As stated above, the gas is considered to be a mixture of ideal gases and the following species are considered: e^- , N , N^+ , N^{++} , O , O^+ , O^{++} , O^- , C , C^+ , C^{++} , C^- , Ar , Ar^+ , Ar^{++} , N_2 , N_2^+ , O_2 , O_2^+ , O_2^- , NO , NO^+ , CO , CO^+ , CN , CO_2 . Individual species properties are calculated by using the partition function of statistical mechanics. For atoms and atomic ions, the sum over the electronic levels is terminated when the principal quantum number is greater than 5, as is done in reference 2. All the levels with energy less than the ionization potential listed by Moore (ref. 26) as well as those approximated by extrapolation along the isoelectronic sequence are included. Many of the higher levels have been grouped by assigning an average energy and adding the degeneracies. For diatoms and diatomic ions, the rotational-vibrational correction terms are considered and electronic energies less than $90,000 \text{ cm}^{-1}$ are used. The summation over rotational states has been treated by using the Mayer and Mayer approach (ref. 21), whereas the summation over vibrational states has been done directly to an approximate cut-off based on the dissociation energy. The rotational and vibrational constants for each electronic state given by Browne (refs. 27 and 28) have been used. These constants are also listed in references 22 and 23. The linear triatomic species CO_2 is approximated by a rigid-rotor harmonic-oscillator model and ground-state rotational-vibrational constants (refs. 22, 23, and 27) have been used.

Determination of the equilibrium composition for a specified T and p is based on the equilibrium criterion

$$(dF)_{T,p} = 0$$

where F is the Gibbs free energy. The method used is one of the methods introduced by White, Johnson, and Dantzig (ref. 24), their "steepest descent" method. This method minimizes a quadratic approximation to the free energy subject to the elemental mass-balance constraints. Generally, the number of simultaneous equations which need to be solved in each iteration is considerably less than n , the total number of species in the mixture. In fact, there are only $m + 1$ equations to solve, where m is the number of elemental components in the mixture.

The Gibbs free energy of the mixture as well as other properties needed in the subsequent section are given below as functions of T , p , Q_i , and y_i . The quantity Q_i is the partition function of the i th species whereas y_i is the number of moles of species i per mass of mixture. Reference 22 or 23 gives the explicit forms of Q_i and other first-order properties.

$$F = M_u \sum_{i=1}^n y_i \left[f_i + RT \left(\log_e \frac{y_i}{\bar{y}} + \log_e \frac{p}{p_o} \right) \right] \quad (1)$$

$$H = M_u \sum_{i=1}^n y_i h_i \quad (2)$$

$$\rho = \frac{p}{RT\bar{y}} \quad (3)$$

where

$$f_i = -RT \log_e Q_i + h_{oi} \quad (4)$$

$$h_i = RT^2 \left(\frac{\partial \log_e Q_i}{\partial T} \right)_p + h_{oi} \quad (5)$$

$$\bar{y} = \sum_{i=1}^n y_i \quad (6)$$

The elemental mass-balance constraints are

$$b_k = \sum_{i=1}^n a_{ik} y_i \quad (k = 1 \text{ to } m) \quad (7)$$

Several of the nondimensional first-order properties are included in the tabulated results for the Mars atmosphere.

Second-Order Properties

In this note, the second-order properties are defined as those which depend on the composition partial derivatives $\left(\frac{\partial y_i}{\partial T}\right)_p$ and $\left(\frac{\partial y_i}{\partial p}\right)_T$. As pointed out in reference 9, the direct calculation of these derivatives for a system of n species generally requires the solution of n linear equations in n unknown derivatives. However, reference 15 shows that the matrix derived from these n equations is almost identical to the one used for computing the corrections to the compositions in the equilibrium iterations. The present method reduces the system to $m + 1$ equations in $m + 1$ unknowns where the matrix of the coefficients is identical to that used in the equilibrium iterations.

Bridgman (ref. 29) shows that all the thermodynamic first derivatives may be expressed in terms of the three derivatives $\left(\frac{\partial V}{\partial T}\right)_p$, $\left(\frac{\partial V}{\partial p}\right)_T$, and C_p , the heat capacity at constant pressure. In this note, the volume V is M_u/ρ and the three fundamental first derivatives computed are $\frac{T}{\rho} \left(\frac{\partial \rho}{\partial T}\right)_p$, $\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p}\right)_T$, and $\frac{C_p}{R}$. With these derivatives and the formulas of reference 29, all other thermodynamic first derivatives can be computed. From the first law of thermodynamics and equations (2) and (3), the desired nondimensional first derivatives are:

$$\frac{T}{\rho} \left(\frac{\partial \rho}{\partial T}\right)_p = - \left[1 + \frac{T}{\bar{y}} \left(\frac{\partial \bar{y}}{\partial T}\right)_p \right] \quad (8)$$

$$\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p}\right)_T = 1 - \frac{p}{\bar{y}} \left(\frac{\partial \bar{y}}{\partial p}\right)_T \quad (9)$$

$$\frac{C_p}{R} = M_u \sum_{i=1}^n \left[y_i \left(\frac{C_{p,i}}{R}\right) + T \left(\frac{h_i}{RT}\right) \left(\frac{\partial y_i}{\partial T}\right)_p \right] \quad (10)$$

It can be seen from equations (6) and (8) to (10) that the quantities $\left(\frac{\partial y_i}{\partial T}\right)_p$ and $\left(\frac{\partial y_i}{\partial p}\right)_T$ must be determined. When equations (1) and (4) are made to satisfy the equilibrium criterion $(dF)_{T,p} = 0$, there results

$$0 = \sum_{i=1}^n \left[h_{oi} + RT \left(\log_e y_i - \log_e Q_i + \log_e \frac{p}{\bar{y}p_o} \right) \right] dy_i \quad (11)$$

The elemental mass-balance constraints (eqs. (7)) give the following m constraints when differentiated:

$$0 = \sum_{i=1}^n a_{ik} dy_i \quad (k = 1 \text{ to } m) \quad (12)$$

Lagrange multipliers r_k are applied to these constraining equations and the result is added to equation (11) to obtain

$$0 = \sum_{i=1}^n \left[h_{oi} + RT \left(\log_e y_i - \log_e Q_i + \log_e \frac{p}{\bar{y}p_o} \right) + \sum_{k=1}^m r_k a_{ik} \right] dy_i \quad (13)$$

In equation (13) each of the n terms of the outermost summation are required to vanish and n equations result:

$$0 = h_{oi} + RT \left(\log_e y_i - \log_e Q_i + \log_e \frac{p}{\bar{y}p_o} \right) + \sum_{k=1}^m r_k a_{ik} \quad (14)$$

where $i = 1$ to n . The remaining $m + 1$ equations required are the mass-balance constraints (eqs. (7)) and the definition of \bar{y} (eq. (6)). Equations (6), (7), and (14) are differentiated with respect to p (T being held constant) and rearranged to give the $n + m + 1$ equations. (These equations as well as the reduced set are essentially those which could be obtained from the more general non-ideal gas equations given in reference 30. However, numerical results are not included therein.)

$$\left. \begin{aligned}
\left(\frac{\partial y_i}{\partial p} \right)_T - \frac{y_i}{\bar{y}} \left(\frac{\partial \bar{y}}{\partial p} \right)_T + \frac{y_i}{RT} \sum_{k=1}^m a_{ik} \left(\frac{\partial r_k}{\partial p} \right)_T &= - \frac{y_i}{p} & (i = 1 \text{ to } n) \\
\sum_{i=1}^n a_{ik} \left(\frac{\partial y_i}{\partial p} \right)_T &= 0 & (k = 1 \text{ to } m) \\
\sum_{i=1}^n \left(\frac{\partial y_i}{\partial p} \right)_T - \left(\frac{\partial \bar{y}}{\partial p} \right)_T &= 0
\end{aligned} \right\} \quad (15)$$

This system of $n + m + 1$ equations is reduced to a system of $m + 1$ equations in the $m + 1$ unknowns $\left(\frac{\partial r_k}{\partial p} \right)_T$ where $k = 1$ to m and $\left(\frac{\partial \bar{y}}{\partial p} \right)_T$ in the following manner. Each of the first n equations is multiplied by a_{i1} and then added to one another. The differentiated constraint equation for $k = 1$ is then subtracted to obtain (after some rearrangement)

$$\sum_{k=1}^m \left[\left(\sum_{i=1}^n y_i a_{i1} a_{ik} \right) \frac{1}{RT} \left(\frac{\partial r_k}{\partial p} \right)_T \right] - \frac{b_1}{\bar{y}} \left(\frac{\partial \bar{y}}{\partial p} \right)_T = - \frac{b_1}{p} \quad (16)$$

This procedure is repeated for the remaining $m - 1$ values of k to generate m equations of the form:

$$\sum_{k=1}^m \left[\left(\sum_{i=1}^n y_i a_{ik'} a_{ik} \right) \frac{1}{RT} \left(\frac{\partial r_k}{\partial p} \right)_T \right] - \frac{b_{k'}}{\bar{y}} \left(\frac{\partial \bar{y}}{\partial p} \right)_T = - \frac{b_{k'}}{p} \quad (k' = 1 \text{ to } m) \quad (17)$$

When the last of equations (15) is subtracted from the sum of the first n equations, there results

$$\sum_{k=1}^m \frac{b_k}{RT} \left(\frac{\partial r_k}{\partial p} \right)_T = - \frac{\bar{y}}{p} \quad (18)$$

If the identifications

$$\left. \begin{aligned} \frac{1}{RT} \left(\frac{\partial r_k}{\partial p} \right)_T &= \pi_k & (k = 1 \text{ to } m) \\ - \frac{1}{\bar{y}} \left(\frac{\partial \bar{y}}{\partial p} \right)_T &= u \end{aligned} \right\} \quad (19)$$

are made, it can be seen that the matrix of the coefficients for the system of equations (17) and (18) is identical to that used in determining the equilibrium concentrations; that is, equations (18) of reference 24 or appendix D of reference 22. When π_k and u have been determined from equations (17) to (19), the n individual species composition derivatives $\left(\frac{\partial y_i}{\partial p} \right)_T$ are obtained from the first n equations of the system given by (15) and the definition (19).

The same procedure is used to obtain the derivatives $\left(\frac{\partial y_i}{\partial T} \right)_p$ and it is found that the system for either set of partial derivatives can be written as:

$$\left. \begin{aligned} \sum_{k=1}^m \left[\left(\sum_{i=1}^n y_i a_{ik} a_{ik} \right) \pi_{kj} \right] + b_k u_j &= \sum_{i=1}^n a_{ik} \psi_{ij} & (k' = 1 \text{ to } m) \\ \sum_{k=1}^m b_k \pi_{kj} &= \sum_{i=1}^n \psi_{ij} \end{aligned} \right\} \quad (20)$$

where the index $j = 1$ gives the pressure derivatives and $j = 2$ the temperature derivatives and

$$\left. \begin{aligned} \psi_{i1} &= - \frac{y_i}{p} \\ \psi_{i2} &= \frac{y_i}{T} \left[\left(\frac{h_i}{RT} \right) - \left(\frac{f_i}{RT} \right) - \log_e \left(\frac{y_i p}{\bar{y} p_0} \right) \right] \\ \pi_{k1} &= \frac{1}{RT} \left(\frac{\partial r_k}{\partial p} \right)_T \\ \pi_{k2} &= \frac{1}{RT} \left(\frac{\partial r_k}{\partial T} \right)_p \end{aligned} \right\} \quad (21)$$

(Equation continued on next page)

$$u_1 = - \frac{1}{\bar{y}} \left(\frac{\partial \bar{y}}{\partial p} \right)_T$$

$$u_2 = - \frac{1}{\bar{y}} \left(\frac{\partial \bar{y}}{\partial T} \right)_p$$

The fundamental first derivatives $\frac{T}{\rho} \left(\frac{\partial \rho}{\partial T} \right)_p$ and $\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p} \right)_T$ are now easily computed from equations (8) and (9). In order to compute C_p/R , the quantities $C_{p,i}/R$ are required. From the definition of $C_{p,i}$ and the first law of thermodynamics,

$$C_{p,i} = \left(\frac{\partial h_i}{\partial T} \right)_p. \text{ It can be seen from equation (5) that the second derivative of the partition}$$

function is required. For atoms and atomic ions the differentiation is straightforward. Since the linear triatomic species CO_2 is taken to be a rigid-rotor harmonic oscillator, its partition function is also easy to differentiate. The diatoms and diatomic ions are more involved because of the rotational-vibrational correction terms. For these species, the procedure used in obtaining the second derivative is the same as that used in reference 23 for obtaining the first derivative. That is, the direct sums of the partition function (or first derivative of it) are differentiated before the Euler-Maclaurin summation formula (p. 152 of ref. 21) is applied to the rotational summation. This formula is then applied to both the function and its first derivative (or the first and second derivatives of the function). The summation over the vibrational states is carried out directly to an approximate cut-off. (See ref. 23.) When these heat capacities of individual species have been determined, the heat capacity for the mixture C_p/R is computed from equation (10).

By using the fundamental first derivatives, the following derivatives of interest are computed:

$$\frac{C_V}{R} = \frac{C_p}{R} - \frac{M_u \bar{y} \left[\frac{T}{\rho} \left(\frac{\partial \rho}{\partial T} \right)_p \right]^2}{\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p} \right)_T} \quad (22)$$

$$\gamma = \frac{C_p}{C_V} \quad (23)$$

$$\gamma_E \equiv \left(\frac{\partial \log_e p}{\partial \log_e \rho} \right)_S = \frac{\gamma}{\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p} \right)_T} \quad (24)$$

where γ_E is the isentropic exponent and is related to the equilibrium speed of sound A as

$$\gamma_E = \frac{A^2 \rho}{p} \quad (25)$$

RESULTS AND DISCUSSION

As stated in the "Introduction," the air results have been computed in order to show, through comparison with other works, the temperature-pressure range in which properties for other atmospheres containing the same major species could be expected to have the same order of accuracy. The air results are discussed first.

Air Comparisons

Hochstim has stated (ref. 1) that the thermodynamic properties of references 2 to 8 agree within about 1 percent. In reference 23, the present first-order properties are shown to agree with those of references 2, 3, and 10 to a few tenths of a percent for $T < 15,000^\circ \text{K}$ and $10^{-4} \leq \frac{p}{p_0} \leq 10^2$. Table I shows a comparison of the present second-order properties γ and γ_E with the same directly computed properties of references 6, 9, and 10 for several temperatures at a density of $\frac{\rho}{\rho_0} = 10^{-3}$. If differences occur, they are generally 1 in the last place quoted. Table II shows a comparison of the present results for C_p/R , C_v/R , γ , and γ_E with the same quantities obtained numerically by Landis and Nilson (ref. 14) who used a "spline fit" procedure on the first-order data of Hilsenrath, et al. (ref. 5). Eight densities are given for each of eight temperatures. For the two highest temperatures ($14,000^\circ \text{K}$ and $14,600^\circ \text{K}$), the same quantities for the imperfect air data of Hilsenrath and Klein (refs. 11 and 12) as computed by Lewis and Neel (ref. 13) are also shown. It can be seen that the present results agree very well, generally to better than 1 percent, with those of Landis and Nilson. The imperfect air results of Lewis and Neel have been given to show that the second-order properties for a mixture of ideal gases may differ by as much as 5 percent (see C_p/R for $T = 14,600^\circ \text{K}$ in table II, for example) from those for a mixture of real gases even though the first-order properties agree within about 1 percent. (See figs. 2 and 3 of ref. 11.) Since the same sort of difference could be expected to occur for other atmospheres containing N, O, C, and Ar, the present method should be expected to give first-order properties to within 1 percent and second-order properties generally to much better than 5 percent for

$T \leq 15,000^\circ \text{ K}$ and $10^{-4} \leq \frac{p}{p_0} \leq 10^2$, the range in which the present results have been extensively checked. It is felt that the lower limit on the pressure can be decreased without substantially changing the percentages shown.

NASA Mars Atmosphere Model 3 Data

Since Bailey (ref. 20) gives results only in graphical form, a good quantitative comparison with the present results cannot be made. Briefly, his assumptions are: mixture of ideal gases; rigid-rotor harmonic-oscillator model for diatoms; and only a few (≈ 5) electronic states for each species. As previously mentioned, his program uses T and ρ as independent variables whereas the present one considers T and p as independent variables.

The present results are presented in figures 1 and 2 and table III. Figures 1(a) to 1(d) show the mass fraction of the major species for the temperatures 3000° K , 6000° K , 9000° K , and $12,000^\circ \text{ K}$. Also given in figures 1(b) and 1(c) are some points (circles and triangles) taken from reference 20. The agreement for the circles is good qualitatively. The triangles are for CN and it can be seen that these points do not agree with the present CN results.

There is a disagreement in the literature concerning the dissociation energy for CN as can be seen in the tabulations of reference 31 and the discussion in reference 32. Bailey has used the value $\approx 8.2 \text{ eV}$ whereas the present work used a lower value $\approx 7.5 \text{ eV}$. It has been pointed out that the radiation from high temperature $\text{CO}_2\text{-N}_2$ mixtures appears to follow the CN concentration (refs. 33 and 34). The uncertainty in the dissociation energy of CN should be resolved because radiative heating calculations for Mars probes will depend strongly on the value since it determines the CN concentration as can be seen in figure 1.

Figures 2(a) to 2(e) show the variation of the isentropic exponent γ_E with $\log_{10}(p/p_0)$ for the temperatures 3000° K , 6000° K , 9000° K , $12,000^\circ \text{ K}$, and $15,000^\circ \text{ K}$. The circles are the points taken from reference 20. It is felt that the differences here are due to the simpler gas model which has been used by Bailey. Since γ_E is a second-order property, larger differences than those found in the first-order properties would be expected.

Table III gives the nondimensional thermodynamic properties $\log_{10}(\rho/\rho_0)$, Z , H/RT , S/R , $\log_{10}N_e$, $\left[\frac{T}{\rho} \left(\frac{\partial \rho}{\partial T}\right)_p\right]$, $\left[\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p}\right)_T\right]$, C_p/R , C_v/R , γ , γ_E , and A/A_0 . These properties are given for 36 pressures, $10^{-5} \leq p/p_0 \leq 10^2$, for each of 56 temperatures, $1000^\circ \text{ K} \leq T \leq 15,000^\circ \text{ K}$. This range has been chosen since the first-order properties quoted should be accurate to about 1 percent and the second-order properties generally

to much better than 5 percent as was the case for the air results. For some properties, values to 6 or 7 figures are given because of the print format used in the machine program. The constants used to nondimensionalize various properties are given in the table. The quantities $\rho_0 = \frac{M_u p_0}{273.15R}$ and $A_0 = \left(1.4 \frac{p_0}{\rho_0}\right)^{1/2}$ are computed and it should be noted that p_0 corresponds to standard earth pressure and not to the Mars surface pressure. Concentrations of all species have not been given since to do so would require many pages. The electron concentration is given in the form $\log_{10} N_e$, and when $-0.$ appears in that column, it means that the mass fraction of electrons was less than about 10^{-10} .

CONCLUDING REMARKS

The directly computed second-order thermodynamic properties agree very well with existing properties (both directly and numerically computed) for air considered as a mixture of ideal gases. Comparison of these results with recent imperfect air results shows that the "mixture of ideal gases approximation" produces acceptable engineering data (error less than 5 percent) for temperatures $\leq 15,000^\circ \text{K}$ and pressures $\leq 10^2$ atmospheres. Tabulated results for the high temperature thermodynamic properties of NASA engineering model Mars atmosphere 3 are given for 36 pressures at each of 56 temperatures.

It is shown that the partial derivatives of the species concentrations needed to determine the second-order properties can be computed by using the same matrix of coefficients as used in the free-energy minimization iterations to determine the equilibrium concentrations.

Langley Research Center,
National Aeronautics and Space Administration,
Langley Station, Hampton, Va., January 14, 1966.

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TABLE I.- COMPARISON OF RATIO OF SPECIFIC HEATS AND ISENTROPIC EXPONENT
WITH EXISTING DIRECTLY COMPUTED PROPERTIES FOR AIR

$$\left[\frac{\rho}{\rho_0} = 10^{-3} \right]$$

Temperature, °K	γ	γ_E	γ	γ_E	γ	γ_E	γ	γ_E
	From present paper		From reference 6		From reference 9		From reference 10	
2000	1.242	1.241	-----	---	1.242	1.241	---	-----
3000	1.181	1.145	1.181	---	1.181	1.145	---	1.146
4000	1.233	1.227	1.231	---	1.233	1.227	---	1.227
5000	1.163	1.121	1.164	---	1.163	1.121	---	1.121
6000	1.224	1.125	1.223	---	1.224	1.125	---	1.125
7000	1.223	1.191	1.224	---	1.223	1.191	---	1.191
8000	1.249	1.238	1.249	---	-----	-----	---	1.238
9000	1.205	1.185	1.204	---	-----	-----	---	1.186
10 000	1.202	1.156	1.202	---	-----	-----	---	1.156
11 000	1.235	1.149	-----	---	-----	-----	---	1.149
12 000	1.280	1.153	-----	---	-----	-----	---	1.153
13 000	1.308	1.164	-----	---	-----	-----	---	1.164
14 000	1.310	1.181	-----	---	-----	-----	---	1.181

TABLE II.- COMPARISON OF SPECIFIC HEATS, RATIO OF SPECIFIC HEATS, AND ISENTROPIC
EXPONENT WITH EXISTING AIR PROPERTIES OBTAINED NUMERICALLY
BY USING A "SPLINE FIT" METHOD

$$[\rho_o = 1.29233 \text{ kg/m}^3; R = 8.31469 \text{ joules/mole-}^\circ\text{K}]$$

$\log_{10} \frac{\rho}{\rho_0}$	C_p/R	C_v/R	γ	γ_E	C_p/R	C_v/R	γ	γ_E
	From present paper				From reference 14*			
	T = 2000° K							
-6.00	24.810	22.078	1.124	1.101	24.773	22.026	1.125	1.101
-5.00	12.245	10.679	1.147	1.138	12.198	10.649	1.145	1.138
-4.00	7.145	5.968	1.197	1.194	7.137	5.958	1.198	1.194
-3.00	5.410	4.355	1.242	1.241	5.410	4.353	1.243	1.241
-2.00	4.849	3.831	1.266	1.265	4.851	3.833	1.266	1.265
-1.00	4.670	3.665	1.274	1.274	4.673	3.667	1.274	1.274
0.00	4.614	3.612	1.277	1.277	4.617	3.615	1.277	1.277
1.00	4.596	3.595	1.278	1.278	4.599	3.599	1.278	1.278
T = 4000° K								
-6.00	75.061	65.252	1.150	1.086	74.966	65.201	1.150	1.086
-5.00	30.559	26.974	1.133	1.106	30.533	26.948	1.133	1.106
-4.00	13.267	11.378	1.166	1.156	13.260	11.370	1.166	1.156
-3.00	7.838	6.356	1.233	1.227	7.842	6.359	1.233	1.226
-2.00	8.017	6.386	1.255	1.240	8.035	6.400	1.256	1.240
-1.00	11.909	9.676	1.231	1.196	11.903	9.671	1.231	1.196
0.00	10.652	8.743	1.218	1.190	10.624	8.720	1.218	1.190
1.00	7.509	6.156	1.220	1.207	7.489	6.140	1.220	1.207
T = 6000° K								
-6.00	13.355	10.826	1.234	1.228	13.276	10.749	1.235	1.229
-5.00	11.792	9.273	1.272	1.264	11.774	9.249	1.273	1.264
-4.00	32.470	27.147	1.196	1.156	32.522	27.182	1.196	1.156
-3.00	62.963	51.447	1.224	1.125	62.953	51.445	1.224	1.125
-2.00	39.852	33.126	1.203	1.130	39.806	33.091	1.203	1.130
-1.00	18.143	15.183	1.195	1.160	18.130	15.172	1.195	1.159
0.00	10.226	8.256	1.239	1.211	10.230	8.259	1.239	1.210
1.00	8.678	6.812	1.274	1.236	8.669	6.807	1.274	1.234

*Data extracted from reference 14 by permission of United Aircraft Corporation.

TABLE II.- COMPARISON OF SPECIFIC HEATS, RATIO OF SPECIFIC HEATS, AND ISENTROPIC EXPONENT WITH EXISTING AIR PROPERTIES OBTAINED NUMERICALLY
BY USING A "SPLINE FIT" METHOD - Continued

$\log_{10} \frac{\rho}{\rho_0}$	C_p/R	C_v/R	γ	γ_E	C_p/R	C_v/R	γ	γ_E
	From present paper				From reference 14*			
T = 8000° K								
-6.00	137.700	113.749	1.211	1.104	137.016	113.244	1.210	1.104
-5.00	55.666	47.604	1.169	1.123	55.333	47.326	1.169	1.123
-4.00	22.991	19.344	1.189	1.171	22.880	19.246	1.189	1.171
-3.00	13.734	10.999	1.249	1.238	13.716	10.981	1.249	1.238
-2.00	22.452	18.131	1.238	1.198	22.525	18.183	1.239	1.198
-1.00	40.895	32.324	1.265	1.162	40.795	32.236	1.265	1.162
0.00	27.546	22.020	1.251	1.167	27.375	21.883	1.251	1.166
1.00	14.059	11.254	1.249	1.196	13.998	11.206	1.249	1.194
T = 10 000° K								
-6.00	72.371	59.751	1.211	1.158	73.042	60.304	1.211	1.157
-5.00	145.217	114.872	1.264	1.128	145.459	115.064	1.264	1.127
-4.00	89.921	72.783	1.235	1.131	89.589	72.545	1.235	1.131
-3.00	37.669	31.346	1.202	1.156	37.507	31.214	1.202	1.156
-2.00	17.778	14.445	1.231	1.211	17.731	14.404	1.231	1.212
-1.00	16.425	12.974	1.266	1.235	16.485	13.019	1.266	1.235
0.00	29.711	22.968	1.294	1.195	29.751	22.991	1.294	1.195
1.00	24.685	19.042	1.296	1.190	24.568	18.965	1.295	1.189
T = 12 000° K								
-6.00	14.186	9.814	1.446	1.441	14.237	9.856	1.444	1.439
-5.00	37.522	29.798	1.259	1.226	37.810	30.031	1.259	1.225
-4.00	101.337	79.245	1.279	1.157	101.735	79.556	1.279	1.157
-3.00	83.317	65.111	1.280	1.153	83.175	65.019	1.279	1.153
-2.00	37.834	30.606	1.236	1.174	37.690	30.487	1.236	1.175
-1.00	18.122	14.487	1.251	1.224	18.046	14.413	1.252	1.225
0.00	16.439	12.742	1.290	1.248	16.451	12.734	1.292	1.249
1.00	25.137	18.890	1.331	1.216	25.034	18.798	1.332	1.216

*Data extracted from reference 14 by permission of United Aircraft Corporation.

TABLE II.- COMPARISON OF SPECIFIC HEATS, RATIO OF SPECIFIC HEATS, AND ISENTROPIC
EXPONENT WITH EXISTING AIR PROPERTIES OBTAINED NUMERICALLY
BY USING A "SPLINE FIT" METHOD - Concluded

$\log_{10} \frac{\rho}{\rho_0}$	$C_{p/R}$	$C_{v/R}$	γ	γ_E	$C_{p/R}$	$C_{v/R}$	γ	γ_E	$C_{p/R}$	$C_{v/R}$	γ	γ_E
	From present paper				From reference 14*				From reference 13			
T = 14 000° K												
-6.00	13.700	9.497	1.442	1.441	13.738	9.533	1.441	1.453	13.751	9.548	1.440	1.439
-5.00	14.064	9.678	1.453	1.448	14.129	9.737	1.451	1.474	14.145	9.740	1.452	1.447
-4.00	33.730	26.144	1.290	1.252	33.954	26.329	1.290	1.255	33.678	26.079	1.291	1.252
-3.00	81.523	62.245	1.310	1.181	81.804	62.457	1.310	1.181	80.842	61.949	1.305	1.178
-2.00	63.287	48.573	1.303	1.178	63.161	48.459	1.303	1.178	64.142	49.492	1.296	1.173
-1.00	29.490	23.357	1.263	1.202	29.263	23.139	1.265	1.204	30.764	24.538	1.254	1.194
0.00	16.023	12.502	1.282	1.249	15.812	12.288	1.287	1.254	16.941	13.359	1.268	1.237
1.00	18.032	13.602	1.326	1.251	17.878	13.429	1.331	1.254	18.753	14.266	1.315	1.253
T = 14 600° K												
-6.00	17.528	13.019	1.346	1.343	17.449	12.931	1.349	1.347	17.543	13.040	1.345	1.342
-5.00	13.217	8.967	1.474	1.471	13.175	8.911	1.479	1.473	13.251	8.998	1.473	1.469
-4.00	24.648	18.569	1.327	1.302	24.701	18.597	1.328	1.302	24.604	18.525	1.328	1.302
-3.00	68.845	52.779	1.304	1.195	69.112	52.961	1.305	1.195	68.001	52.258	1.301	1.193
-2.00	68.157	51.589	1.321	1.182	68.103	51.507	1.322	1.183	68.661	52.292	1.313	1.177
-1.00	33.631	26.386	1.275	1.200	33.362	26.120	1.277	1.203	35.067	27.723	1.265	1.191
0.00	17.216	13.461	1.279	1.243	16.918	13.161	1.285	1.249	18.341	14.505	1.264	1.230
1.00	16.634	12.582	1.322	1.258	16.401	12.332	1.330	1.263	17.548	13.440	1.306	1.255

*Data extracted from reference 14 by permission of United Aircraft Corporation.

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING
MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL

[80% CO₂, 40% N₂ by mass; P₀ = 1.01325 × 10⁵ N/m²; ρ₀ = 1.59842 kg/m³; R = 8.31469 J/mole-°K;

A₀ = 2.97904 × 10² m/sec; and M_u = 35.828]

T = 1000 K												
log ₁₀ P/P ₀	log ₁₀ ρ/ρ ₀	Z	H RT	S R	log ₁₀ N _e	T(θP) P(θP) _T	P(θP) P(θP) _T	C _p R	C _v R	γ	γ _E	A A ₀
-5.0	-5.5636	1.0000	-18.7320	42.0472	-0.	-1.001	1.000	5.195	4.193	1.239	1.239	1.800
-4.9	-5.5636	1.0000	-18.7320	41.5866	-0.	-1.001	1.000	5.193	4.192	1.239	1.239	1.800
-4.6	-5.1636	1.0000	-18.7319	41.1257	-0.	-1.000	1.000	5.193	4.193	1.239	1.239	1.800
-4.4	-4.5636	1.0000	-18.7320	40.6552	-0.	-1.000	1.000	5.193	4.192	1.239	1.239	1.800
-4.2	-4.7636	1.0000	-18.7320	40.2049	-0.	-1.001	1.000	5.192	4.191	1.239	1.239	1.800
-4.0	-4.5636	1.0000	-18.7321	39.7443	-0.	-1.001	1.000	5.193	4.192	1.239	1.239	1.800
-3.8	-4.7636	1.0000	-18.7321	39.2839	-0.	-1.001	1.000	5.191	4.190	1.239	1.239	1.800
-3.6	-4.1636	1.0000	-18.7321	38.8234	-0.	-1.001	1.000	5.192	4.191	1.239	1.239	1.800
-3.4	-3.9636	1.0000	-18.7321	38.3629	-0.	-1.001	1.000	5.193	4.192	1.239	1.239	1.800
-3.2	-3.7636	1.0000	-18.7321	37.9022	-0.	-1.000	1.000	5.193	4.192	1.239	1.239	1.800
-3.0	-3.5636	1.0000	-18.7321	37.4417	-0.	-1.000	1.000	5.193	4.192	1.239	1.239	1.800
-2.8	-3.3636	1.0000	-18.7320	36.9811	-0.	-1.000	1.000	5.192	4.191	1.239	1.239	1.800
-2.6	-3.1636	1.0000	-18.7321	36.5206	-0.	-1.000	1.000	5.193	4.192	1.239	1.239	1.800
-2.4	-2.9636	1.0000	-18.7321	36.0601	-0.	-1.000	1.000	5.193	4.192	1.239	1.239	1.800
-2.2	-2.7636	1.0000	-18.7320	35.5995	-0.	-1.000	1.000	5.191	4.190	1.239	1.239	1.800
-2.0	-2.5636	1.0000	-18.7321	35.1391	-0.	-1.000	1.000	5.192	4.191	1.239	1.239	1.800
-1.8	-2.3636	1.0000	-18.7320	34.6786	-0.	-1.000	1.000	5.191	4.190	1.239	1.239	1.800
-1.6	-2.1636	1.0000	-18.7321	34.2180	-0.	-1.000	1.000	5.192	4.191	1.239	1.239	1.800
-1.4	-1.9636	1.0000	-18.7321	33.7576	-0.	-1.000	1.000	5.192	4.191	1.239	1.239	1.800
-1.2	-1.7636	1.0000	-18.7320	33.2971	-0.	-1.000	1.000	5.190	4.190	1.239	1.239	1.800
-1.0	-1.5636	1.0000	-18.7320	32.8365	-0.	-1.000	1.000	5.191	4.190	1.239	1.239	1.800
-0.8	-1.3636	1.0000	-18.7321	32.3761	-0.	-1.000	1.000	5.192	4.192	1.239	1.239	1.800
-0.6	-1.1636	1.0000	-18.7320	31.9156	-0.	-1.000	1.000	5.192	4.191	1.239	1.239	1.800
-0.4	-0.9636	1.0000	-18.7322	31.4552	-0.	-1.000	1.000	5.192	4.191	1.239	1.239	1.800
-0.2	-0.7636	1.0000	-18.7320	30.9945	-0.	-1.000	1.000	5.190	4.190	1.239	1.239	1.800
0.	-0.5636	1.0000	-18.7321	30.5341	-0.	-1.000	1.000	5.191	4.191	1.239	1.239	1.800
0.2	-0.3636	1.0000	-18.7320	30.0736	-0.	-1.000	1.000	5.191	4.191	1.239	1.239	1.800
0.4	-0.1636	1.0000	-18.7320	29.6130	-0.	-1.000	1.000	5.191	4.191	1.239	1.239	1.800
0.6	0.0364	1.0000	-18.7321	29.1528	-0.	-1.001	1.000	5.191	4.190	1.239	1.239	1.800
0.8	0.2364	1.0000	-18.7321	28.6921	-0.	-1.000	1.000	5.192	4.191	1.239	1.239	1.800
1.0	0.4364	1.0000	-18.7320	28.2315	-0.	-1.000	1.000	5.191	4.190	1.239	1.239	1.800
1.2	0.6364	1.0000	-18.7320	27.7710	-0.	-1.000	1.000	5.191	4.191	1.239	1.239	1.800
1.4	0.8364	1.0000	-18.7321	27.3105	-0.	-1.000	1.000	5.191	4.190	1.239	1.239	1.800
1.6	1.0364	1.0000	-18.7321	26.8499	-0.	-1.000	1.000	5.191	4.191	1.239	1.239	1.800
1.8	1.2364	1.0000	-18.7321	26.3895	-0.	-1.000	1.000	5.191	4.190	1.239	1.239	1.800
2.0	1.4364	1.0000	-18.7321	25.9290	-0.	-1.000	1.000	5.191	4.191	1.239	1.239	1.800
T = 1200 K												
-5.0	-5.4428	1.0001	-14.7226	43.0170	-0.	-1.003	1.000	5.500	4.494	1.224	1.224	1.960
-4.8	-5.4428	1.0001	-14.7225	42.5555	-0.	-1.003	1.000	5.481	4.476	1.225	1.225	1.960
-4.6	-5.2428	1.0001	-14.7244	42.0941	-0.	-1.002	1.000	5.465	4.461	1.225	1.225	1.961
-4.4	-5.0428	1.0001	-14.7251	41.6329	-0.	-1.002	1.000	5.452	4.448	1.226	1.226	1.961
-4.2	-4.8428	1.0000	-14.7258	41.1716	-0.	-1.002	1.000	5.440	4.437	1.226	1.226	1.962
-4.0	-4.6428	1.0000	-14.7268	40.7106	-0.	-1.002	1.000	5.429	4.426	1.227	1.227	1.962
-3.8	-4.4428	1.0000	-14.7277	40.2495	-0.	-1.001	1.000	5.421	4.416	1.227	1.227	1.962
-3.6	-4.2428	1.0000	-14.7271	39.7886	-0.	-1.001	1.000	5.414	4.412	1.227	1.227	1.962
-3.4	-4.0428	1.0000	-14.7275	39.3279	-0.	-1.001	1.000	5.408	4.405	1.228	1.228	1.963
-3.2	-3.8428	1.0000	-14.7277	38.8668	-0.	-1.001	1.000	5.402	4.400	1.228	1.228	1.963
-3.0	-3.6428	1.0000	-14.7260	38.4061	-0.	-1.001	1.000	5.398	4.396	1.228	1.228	1.963
-2.8	-3.4428	1.0000	-14.7292	37.9454	-0.	-1.001	1.000	5.393	4.392	1.228	1.228	1.963
-2.6	-3.2428	1.0000	-14.7284	37.4846	-0.	-1.001	1.000	5.389	4.388	1.228	1.228	1.963
-2.4	-3.0428	1.0000	-14.7286	37.0241	-0.	-1.001	1.000	5.387	4.385	1.228	1.228	1.963
-2.2	-2.8428	1.0000	-14.7287	36.5635	-0.	-1.001	1.000	5.384	4.382	1.229	1.229	1.963
-2.0	-2.6428	1.0000	-14.7287	36.1027	-0.	-1.001	1.000	5.382	4.381	1.229	1.229	1.963
-1.8	-2.4428	1.0000	-14.7288	35.6420	-0.	-1.000	1.000	5.380	4.379	1.229	1.229	1.963
-1.6	-2.2428	1.0000	-14.7287	35.1814	-0.	-1.000	1.000	5.378	4.377	1.229	1.229	1.964
-1.4	-2.0428	1.0000	-14.7290	34.7209	-0.	-1.000	1.000	5.377	4.376	1.229	1.229	1.964
-1.2	-1.8428	1.0000	-14.7290	34.2603	-0.	-1.000	1.000	5.376	4.375	1.229	1.229	1.964
-1.0	-1.6428	1.0000	-14.7291	33.7997	-0.	-1.000	1.000	5.375	4.374	1.229	1.229	1.964
-0.8	-1.4428	1.0000	-14.7291	33.3391	-0.	-1.000	1.000	5.374	4.373	1.229	1.229	1.964
-0.6	-1.2428	1.0000	-14.7292	32.8787	-0.	-1.000	1.000	5.373	4.372	1.229	1.229	1.964
-0.4	-1.0428	1.0000	-14.7293	32.4182	-0.	-1.000	1.000	5.372	4.371	1.229	1.229	1.964
-0.2	-0.8428	1.0000	-14.7292	31.9576	-0.	-1.000	1.000	5.371	4.370	1.229	1.229	1.964
0.	-0.6428	1.0000	-14.7292	31.4970	-0.	-1.000	1.000	5.371	4.371	1.229	1.229	1.964
0.2	-0.4428	1.0000	-14.7293	31.0365	-0.	-1.000	1.000	5.371	4.370	1.229	1.229	1.964
0.4	-0.2428	1.0000	-14.7293	30.5760	-0.	-1.000	1.000	5.370	4.369	1.229	1.229	1.964
0.6	-0.0428	1.0000	-14.7293	30.1155	-0.	-1.000	1.000	5.370	4.370	1.229	1.229	1.964
0.8	0.1572	1.0000	-14.7294	29.6551	-0.	-1.000	1.000	5.370	4.369	1.229	1.229	1.964
1.0	0.3572	1.0000	-14.7294	29.1946	-0.	-1.000	1.000	5.369	4.368	1.229	1.229	1.964
1.2	0.5572	1.0000	-14.7293	28.7340	-0.	-1.000	1.000	5.369	4.369	1.229	1.229	1.964
1.4	0.7572	1.0000	-14.7293	28.2735	-0.	-1.000	1.000	5.369	4.369	1.229	1.229	1.964
1.6	0.9572	1.0000	-14.7293	27.8129	-0.	-1.000	1.000	5.369	4.368	1.229	1.229	1.964
1.8	1.1572	1.0000	-14.7294	27.3524	-0.	-1.000	1.000	5.369	4.369	1.229	1.229	1.964
2.0	1.3572	1.0000	-14.7293	26.8919	-0.	-1.000	1.000	5.368	4.368	1.229	1.229	1.964

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 1400 K											
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{s}{R}$	$\log_{10} N_e$	$\frac{T(\theta p)}{p(\theta T)_p}$	$\frac{p(\theta p)}{p(\theta T)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	$\frac{A}{A_0}$
-5.0	-5.7105	1.0018	-11.7616	43.9402	-0.	-1.030	1.001	6.899	5.838	1.182	2.081
-4.8	-5.5104	1.0015	-11.7739	43.4664	-0.	-1.025	1.001	6.700	5.648	1.186	2.085
-4.6	-5.3103	1.0013	-11.7845	42.9948	-0.	-1.022	1.000	6.530	5.485	1.191	2.089
-4.4	-5.1102	1.0011	-11.7936	42.5245	-0.	-1.019	1.000	6.385	5.346	1.194	2.092
-4.2	-4.9101	1.0009	-11.8013	42.0556	-0.	-1.016	1.000	6.259	5.226	1.198	2.095
-4.0	-4.7101	1.0008	-11.8080	41.5878	-0.	-1.014	1.000	6.151	5.123	1.201	2.097
-3.8	-4.5100	1.0007	-11.8137	41.1213	-0.	-1.012	1.000	6.059	5.034	1.204	2.100
-3.6	-4.3100	1.0006	-11.8187	40.6555	-0.	-1.010	1.000	5.979	4.958	1.206	2.102
-3.4	-4.1059	1.0005	-11.8229	40.1906	-0.	-1.009	1.000	5.912	4.893	1.208	2.103
-3.2	-3.9055	1.0004	-11.8265	39.7261	-0.	-1.008	1.000	5.853	4.837	1.210	2.105
-3.0	-3.7055	1.0004	-11.8297	39.2624	-0.	-1.007	1.000	5.803	4.790	1.212	2.106
-2.8	-3.5055	1.0003	-11.8323	38.7991	-0.	-1.006	1.000	5.760	4.748	1.213	2.108
-2.6	-3.3055	1.0003	-11.8347	38.3350	-0.	-1.005	1.000	5.723	4.713	1.214	2.109
-2.4	-3.1056	1.0002	-11.8366	37.8735	-0.	-1.004	1.000	5.691	4.683	1.215	2.110
-2.2	-2.9056	1.0002	-11.8383	37.4111	-0.	-1.004	1.000	5.665	4.657	1.216	2.110
-2.0	-2.7056	1.0002	-11.8398	36.9491	-0.	-1.003	1.000	5.641	4.634	1.217	2.111
-1.8	-2.5056	1.0001	-11.8409	36.4872	-0.	-1.003	1.000	5.621	4.615	1.218	2.112
-1.6	-2.3056	1.0001	-11.8421	36.0256	-0.	-1.002	1.000	5.603	4.598	1.219	2.112
-1.4	-2.1056	1.0001	-11.8430	35.5641	-0.	-1.002	1.000	5.588	4.584	1.219	2.113
-1.2	-1.9056	1.0001	-11.8438	35.1028	-0.	-1.002	1.000	5.576	4.572	1.220	2.113
-1.0	-1.7057	1.0001	-11.8445	34.6415	-0.	-1.002	1.000	5.565	4.562	1.220	2.113
-0.8	-1.5057	1.0000	-11.8451	34.1804	-0.	-1.001	1.000	5.556	4.553	1.220	2.114
-0.6	-1.3057	1.0000	-11.8456	33.7194	-0.	-1.001	1.000	5.547	4.545	1.221	2.114
-0.4	-1.1057	1.0000	-11.8460	33.2585	-0.	-1.001	1.000	5.540	4.538	1.221	2.114
-0.2	-0.9057	1.0000	-11.8463	32.7974	-0.	-1.001	1.000	5.534	4.532	1.221	2.114
0.	-0.7057	1.0000	-11.8466	32.3366	-0.	-1.001	1.000	5.529	4.527	1.221	2.114
0.2	-0.5057	1.0000	-11.8469	31.8758	-0.	-1.001	1.000	5.525	4.524	1.221	2.115
0.4	-0.3057	1.0000	-11.8471	31.4151	-0.	-1.001	1.000	5.521	4.520	1.222	2.115
0.6	-0.1057	1.0000	-11.8474	30.9544	-0.	-1.001	1.000	5.518	4.517	1.222	2.115
0.8	0.1057	1.0000	-11.8476	30.4937	-0.	-1.001	1.000	5.515	4.514	1.222	2.115
1.0	0.3057	1.0000	-11.8477	30.0330	-0.	-1.000	1.000	5.513	4.512	1.222	2.115
1.2	0.5057	1.0000	-11.8478	29.5724	-0.	-1.000	1.000	5.511	4.510	1.222	2.115
1.4	0.7057	1.0000	-11.8479	29.1117	-0.	-1.000	1.000	5.509	4.508	1.222	2.115
1.6	0.9057	1.0000	-11.8480	28.6512	-0.	-1.000	1.000	5.507	4.506	1.222	2.115
1.8	1.1057	1.0000	-11.8481	28.1906	-0.	-1.000	1.000	5.506	4.506	1.222	2.115
2.0	1.3057	1.0000	-11.8481	27.7300	-0.	-1.000	1.000	5.505	4.504	1.222	2.115
T = 1600 K											
-5.0	-5.7735	1.0132	-9.1117	45.1908	-7.	-1.183	1.004	13.388	11.975	1.118	2.172
-4.8	-5.5726	1.0114	-9.1908	44.6454	-0.	-1.158	1.004	12.301	10.950	1.123	2.176
-4.6	-5.3720	1.0098	-9.2598	44.1120	-0.	-1.136	1.003	11.366	10.067	1.129	2.181
-4.4	-5.1714	1.0084	-9.3173	43.5847	-0.	-1.117	1.003	10.557	9.303	1.135	2.185
-4.2	-4.9708	1.0072	-9.3676	43.0745	-0.	-1.101	1.002	9.862	8.644	1.141	2.190
-4.0	-4.7704	1.0064	-9.4108	42.5677	-0.	-1.087	1.002	9.264	8.078	1.147	2.195
-3.8	-4.5700	1.0053	-9.4473	42.0673	-0.	-1.075	1.002	8.749	7.590	1.153	2.200
-3.6	-4.3657	1.0046	-9.4799	41.5727	-0.	-1.064	1.002	8.307	7.171	1.158	2.205
-3.4	-4.1654	1.0033	-9.5071	41.0828	-0.	-1.055	1.001	7.925	6.809	1.164	2.210
-3.2	-3.9652	1.0033	-9.5307	40.5971	-0.	-1.047	1.001	7.599	6.499	1.169	2.214
-3.0	-3.7650	1.0029	-9.5508	40.1149	-0.	-1.041	1.001	7.317	6.231	1.174	2.219
-2.8	-3.5648	1.0025	-9.5682	39.6359	-0.	-1.035	1.001	7.075	6.001	1.179	2.223
-2.6	-3.3646	1.0021	-9.5831	39.1594	-0.	-1.030	1.001	6.867	5.804	1.183	2.226
-2.4	-3.1645	1.0018	-9.5959	38.6852	-0.	-1.026	1.001	6.689	5.635	1.187	2.230
-2.2	-2.9644	1.0015	-9.6068	38.2123	-0.	-1.022	1.001	6.535	5.489	1.191	2.233
-2.0	-2.7643	1.0013	-9.6165	37.7423	-0.	-1.019	1.000	6.403	5.363	1.194	2.236
-1.8	-2.5642	1.0011	-9.6244	37.2730	-0.	-1.017	1.000	6.289	5.255	1.197	2.239
-1.6	-2.3641	1.0010	-9.6313	36.8050	-0.	-1.014	1.000	6.192	5.163	1.199	2.241
-1.4	-2.1641	1.0008	-9.6373	36.3381	-0.	-1.012	1.000	6.108	5.083	1.202	2.243
-1.2	-1.9640	1.0007	-9.6425	35.8721	-0.	-1.011	1.000	6.036	5.015	1.204	2.245
-1.0	-1.7638	1.0006	-9.6469	35.4069	-0.	-1.009	1.000	5.974	4.956	1.206	2.246
-0.8	-1.5637	1.0005	-9.6507	34.9423	-0.	-1.008	1.000	5.921	4.905	1.207	2.248
-0.6	-1.3636	1.0004	-9.6535	34.4783	-0.	-1.007	1.000	5.876	4.862	1.209	2.249
-0.4	-1.1635	1.0004	-9.6562	34.0148	-0.	-1.006	1.000	5.830	4.825	1.210	2.250
-0.2	-0.9634	1.0003	-9.6591	33.5517	-0.	-1.005	1.000	5.803	4.793	1.211	2.251
0.	-0.7633	1.0002	-9.6612	33.0880	-0.	-1.004	1.000	5.774	4.765	1.212	2.252
0.2	-0.5632	1.0002	-9.6630	32.6246	-0.	-1.004	1.000	5.749	4.741	1.213	2.253
0.4	-0.3631	1.0002	-9.6645	32.1644	-0.	-1.003	1.000	5.727	4.721	1.213	2.253
0.6	-0.1630	1.0002	-9.6659	31.7026	-0.	-1.003	1.000	5.709	4.703	1.214	2.254
0.8	0.0372	1.0001	-9.6670	31.2408	-0.	-1.002	1.000	5.693	4.688	1.214	2.254
1.0	0.2372	1.0001	-9.6680	30.7793	-0.	-1.002	1.000	5.679	4.675	1.215	2.255
1.2	0.4372	1.0001	-9.6688	30.3178	-0.	-1.002	1.000	5.668	4.664	1.215	2.255
1.4	0.6373	1.0001	-9.6695	29.8566	-0.	-1.002	1.000	5.657	4.654	1.216	2.255
1.6	0.8373	1.0001	-9.6701	29.3954	-0.	-1.001	1.000	5.649	4.646	1.216	2.256
1.8	1.0373	1.0000	-9.6707	28.9343	-0.	-1.001	1.000	5.641	4.639	1.216	2.256
2.0	1.2373	1.0000	-9.6711	28.4733	-0.	-1.001	1.000	5.635	4.632	1.216	2.256

TABLE III - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5$ N/m²; $\rho_0 = 1.59842$ kg/m³; $R = 8.31469$ J/mole-°K; $A_0 = 2.97904 \times 10^2$ m/sec; and $M_{11} = 35.828$]

T = 1800 K												
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{s}{R}$	$\log_{10} N_e$	$\frac{T(p/p_0)}{\rho(\rho/\rho_0)}$	$\frac{p(p/p_0)}{\rho(\rho/\rho_0)}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{\Delta}{A_0}$
-5.0	-5.8444	1.0605	-5.7207	47.6909	-0.	-1.667	1.018	31.770	28.875	1.100	1.081	2.323
-4.8	-5.6410	1.0522	-6.0248	46.9003	-0.	-1.586	1.016	28.459	25.854	1.101	1.084	2.317
-4.6	-5.4380	1.0451	-6.2894	46.1529	-0.	-1.513	1.014	25.529	23.145	1.102	1.087	2.312
-4.4	-5.2354	1.0385	-6.5194	45.4429	-0.	-1.448	1.012	22.933	20.782	1.104	1.090	2.309
-4.2	-5.0332	1.0335	-6.7189	44.7655	-0.	-1.390	1.010	20.657	18.680	1.106	1.094	2.307
-4.0	-4.8312	1.0289	-6.8916	44.1190	-0.	-1.339	1.009	18.661	16.831	1.109	1.099	2.307
-3.8	-4.6295	1.0248	-7.0410	43.4967	-0.	-1.295	1.008	16.910	15.211	1.112	1.103	2.307
-3.6	-4.4291	1.0214	-7.1702	42.8964	-0.	-1.256	1.007	15.396	13.796	1.116	1.108	2.308
-3.4	-4.2268	1.0184	-7.2817	42.3153	-0.	-1.221	1.006	14.074	12.564	1.120	1.114	2.310
-3.2	-4.0257	1.0158	-7.3779	41.7504	-0.	-1.191	1.005	12.925	11.491	1.125	1.119	2.313
-3.0	-3.8247	1.0136	-7.4605	41.2003	-0.	-1.165	1.004	11.930	10.560	1.130	1.125	2.317
-2.8	-3.6239	1.0117	-7.5323	40.6622	-0.	-1.142	1.004	11.067	9.752	1.135	1.131	2.320
-2.6	-3.4232	1.0100	-7.5938	40.1353	-0.	-1.123	1.003	10.323	9.053	1.140	1.136	2.324
-2.4	-3.2226	1.0086	-7.6468	39.6176	-0.	-1.106	1.003	9.679	8.449	1.146	1.142	2.329
-2.2	-3.0221	1.0074	-7.6924	39.1077	-0.	-1.091	1.002	9.124	7.927	1.151	1.148	2.333
-2.0	-2.8216	1.0064	-7.7317	38.6048	-0.	-1.079	1.002	8.645	7.476	1.156	1.154	2.338
-1.8	-2.6212	1.0055	-7.7654	38.1079	-0.	-1.068	1.002	8.231	7.087	1.162	1.159	2.342
-1.6	-2.4209	1.0047	-7.7944	37.6159	-0.	-1.058	1.002	7.875	6.752	1.166	1.165	2.347
-1.4	-2.2206	1.0040	-7.8194	37.1284	-0.	-1.050	1.001	7.569	6.463	1.171	1.170	2.351
-1.2	-2.0204	1.0035	-7.8409	36.6449	-0.	-1.043	1.001	7.304	6.213	1.176	1.174	2.355
-1.0	-1.8202	1.0030	-7.8584	36.1643	-0.	-1.037	1.001	7.077	5.999	1.180	1.179	2.359
-0.8	-1.6200	1.0025	-7.8752	35.6866	-0.	-1.032	1.001	6.881	5.814	1.184	1.183	2.362
-0.6	-1.4198	1.0022	-7.8898	35.2113	-0.	-1.028	1.001	6.713	5.655	1.187	1.186	2.365
-0.4	-1.2197	1.0019	-7.9006	34.7381	-0.	-1.024	1.001	6.568	5.518	1.190	1.189	2.368
-0.2	-1.0195	1.0016	-7.9107	34.2667	-0.	-1.021	1.001	6.443	5.400	1.193	1.192	2.371
0.	-0.8195	1.0014	-7.9194	33.7968	-0.	-1.018	1.000	6.336	5.299	1.196	1.195	2.373
0.2	-0.6194	1.0012	-7.9269	33.3282	-0.	-1.015	1.000	6.243	5.212	1.198	1.197	2.375
0.4	-0.4193	1.0010	-7.9334	32.8609	-0.	-1.013	1.000	6.164	5.137	1.200	1.200	2.377
0.6	-0.2192	1.0009	-7.9398	32.3943	-0.	-1.011	1.000	6.095	5.072	1.202	1.201	2.379
0.8	-0.0192	1.0007	-7.9436	31.9287	-0.	-1.010	1.000	6.036	5.016	1.203	1.203	2.381
1.0	0.1805	1.0006	-7.9477	31.4637	-0.	-1.008	1.000	5.986	4.968	1.205	1.205	2.382
1.2	0.3809	1.0005	-7.9513	30.9994	-0.	-1.007	1.000	5.942	4.927	1.206	1.206	2.383
1.4	0.5805	1.0005	-7.9543	30.5356	-0.	-1.006	1.000	5.904	4.891	1.207	1.207	2.384
1.6	0.7810	1.0004	-7.9569	30.0723	-0.	-1.005	1.000	5.872	4.860	1.208	1.208	2.385
1.8	0.9810	1.0003	-7.9591	29.6093	-0.	-1.005	1.000	5.844	4.834	1.209	1.209	2.386
2.0	1.1810	1.0003	-7.9611	29.1467	-0.	-1.004	1.000	5.820	4.811	1.210	1.209	2.386
T = 2000 K												
-5.0	-5.6365	1.1799	-0.6608	52.3950	-0.	-2.350	1.042	57.254	51.000	1.123	1.078	2.579
-4.8	-5.4285	1.1564	-1.3595	51.1531	-0.	-2.247	1.038	52.670	47.039	1.120	1.078	2.556
-4.6	-5.2111	1.1390	-1.9909	49.9977	-0.	-2.142	1.035	48.181	43.134	1.117	1.079	2.536
-4.4	-5.0145	1.1216	-2.5578	48.9105	-0.	-2.038	1.032	43.886	39.372	1.115	1.080	2.518
-4.2	-4.8105	1.1062	-3.0638	47.8917	-0.	-1.937	1.029	39.841	35.804	1.113	1.082	2.502
-4.0	-4.6031	1.0925	-3.5138	46.9353	-0.	-1.842	1.026	36.076	32.463	1.111	1.084	2.488
-3.8	-4.3962	1.0805	-3.9118	46.0369	-0.	-1.752	1.023	32.613	29.372	1.110	1.086	2.477
-3.6	-4.1940	1.0690	-4.2628	45.1909	-0.	-1.668	1.020	29.453	26.535	1.110	1.088	2.467
-3.4	-4.0002	1.0606	-4.5712	44.3919	-0.	-1.591	1.018	26.594	23.955	1.110	1.091	2.460
-3.2	-3.8068	1.0525	-4.8415	43.6351	-0.	-1.521	1.016	24.024	21.626	1.111	1.094	2.454
-3.0	-3.6135	1.0454	-5.0776	42.9161	-0.	-1.458	1.014	21.729	19.536	1.112	1.097	2.449
-2.8	-3.4203	1.0392	-5.2835	42.2301	-0.	-1.401	1.012	19.690	17.673	1.114	1.101	2.446
-2.6	-3.2271	1.0338	-5.4626	41.5734	-0.	-1.351	1.010	17.886	16.019	1.117	1.105	2.444
-2.4	-3.0340	1.0292	-5.6182	40.9431	-0.	-1.306	1.009	16.297	14.558	1.119	1.109	2.444
-2.2	-2.8410	1.0252	-5.7532	40.3352	-0.	-1.266	1.008	14.903	13.272	1.123	1.114	2.444
-2.0	-2.6480	1.0217	-5.8701	39.7460	-0.	-1.231	1.007	13.682	12.144	1.127	1.119	2.445
-1.8	-2.4550	1.0187	-5.9712	39.1760	-0.	-1.201	1.006	12.617	11.157	1.131	1.124	2.447
-1.6	-2.2620	1.0161	-6.0586	38.6203	-0.	-1.174	1.005	11.689	10.296	1.135	1.129	2.450
-1.4	-2.0690	1.0139	-6.1341	38.0773	-0.	-1.151	1.004	10.883	9.547	1.140	1.135	2.453
-1.2	-1.8760	1.0119	-6.1993	37.5456	-0.	-1.130	1.004	10.182	8.895	1.145	1.140	2.457
-1.0	-1.6830	1.0103	-6.2555	37.0238	-0.	-1.112	1.003	9.575	8.329	1.150	1.146	2.460
-0.8	-1.4900	1.0088	-6.3040	36.5105	-0.	-1.097	1.003	9.050	7.839	1.154	1.151	2.464
-0.6	-1.2970	1.0076	-6.3457	36.0044	-0.	-1.084	1.002	8.595	7.415	1.159	1.156	2.469
-0.4	-1.1040	1.0065	-6.3817	35.5045	-0.	-1.072	1.002	8.202	7.047	1.164	1.161	2.473
-0.2	-0.9110	1.0056	-6.4127	35.0102	-0.	-1.062	1.002	7.863	6.730	1.168	1.166	2.477
0.	-0.7180	1.0048	-6.4395	34.5207	-0.	-1.054	1.002	7.570	6.456	1.173	1.171	2.480
0.2	-0.5250	1.0041	-6.4623	34.0351	-0.	-1.046	1.001	7.317	6.219	1.177	1.175	2.484
0.4	-0.3320	1.0036	-6.4823	33.5529	-0.	-1.040	1.001	7.099	6.015	1.180	1.179	2.487
0.6	-0.1390	1.0031	-6.4994	33.0738	-0.	-1.035	1.001	6.911	5.838	1.184	1.182	2.491
0.8	0.0540	1.0026	-6.5141	32.5973	-0.	-1.030	1.001	6.748	5.686	1.187	1.186	2.494
1.0	0.2610	1.0023	-6.5268	32.1230	-0.	-1.026	1.001	6.609	5.555	1.190	1.189	2.496
1.2	0.4680	1.0019	-6.5376	31.6505	-0.	-1.022	1.001	6.488	5.442	1.192	1.191	2.499
1.4	0.6750	1.0017	-6.5471	31.1799	-0.	-1.019	1.001	6.384	5.344	1.195	1.194	2.501
1.6	0.8820	1.0014	-6.5552	30.7105	-0.	-1.017	1.000	6.294	5.260	1.197	1.196	2.503
1.8	1.0890	1.0012	-6.5622	30.2424	-0.	-1.014	1.000	6.217	5.187	1.198	1.198	2.505
2.0	1.2960	1.0011	-6.5682	29.7753	-0.	-1.012	1.000	6.150	5.124	1.200	1.200	2.506

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 2200 K											
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{h}{RT}$	$\frac{s}{R}$	$\log_{10} n_e$	$\frac{T(p/p_0)}{p(T/p_0)}$	$\frac{p(p/p_0)}{p(T/p_0)}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	$\frac{A}{A_0}$
-5.0	-6.0278	1.3545	4.9744	58.2394	5.003	-2.332	1.047	57.183	50.146	1.140	1.089
-4.8	-5.8242	1.3248	4.1273	56.7753	5.123	-2.407	1.044	59.107	51.793	1.141	1.088
-4.6	-5.6133	1.2549	3.2656	55.3144	5.240	-2.430	1.050	59.031	51.747	1.141	1.087
-4.4	-5.4034	1.2656	2.4303	53.8855	-0.	-2.412	1.049	57.462	50.438	1.139	1.086
-4.2	-5.1938	1.2381	1.6235	52.5070	-0.	-2.365	1.047	54.914	48.298	1.137	1.086
-4.0	-4.9896	1.2123	0.8763	51.1907	-0.	-2.299	1.045	51.804	45.666	1.134	1.086
-3.8	-4.7610	1.1825	0.1757	49.7413	-0.	-2.221	1.042	48.417	42.789	1.132	1.086
-3.6	-4.5730	1.1667	-0.4556	48.7599	-0.	-2.137	1.039	44.941	39.812	1.129	1.087
-3.4	-4.3656	1.1470	-1.0417	47.6452	-0.	-2.049	1.035	41.489	36.837	1.126	1.088
-3.2	-4.1598	1.1253	-1.5697	46.5940	-0.	-1.961	1.032	38.136	33.927	1.124	1.089
-3.0	-3.9527	1.1134	-2.0425	45.6039	-0.	-1.875	1.029	34.932	31.128	1.122	1.090
-2.8	-3.7471	1.0992	-2.4670	44.6700	-0.	-1.792	1.026	31.900	28.469	1.121	1.092
-2.6	-3.5421	1.0866	-2.8450	43.7838	-0.	-1.712	1.024	29.084	25.977	1.120	1.094
-2.4	-3.3376	1.0754	-3.1805	42.9556	-0.	-1.637	1.021	26.474	23.652	1.119	1.096
-2.2	-3.1336	1.0656	-3.4770	42.1661	-0.	-1.567	1.019	24.085	21.516	1.119	1.099
-2.0	-2.9301	1.0569	-3.7392	41.4163	-0.	-1.503	1.017	21.914	19.566	1.120	1.102
-1.8	-2.7259	1.0494	-3.9757	40.7019	-0.	-1.444	1.015	19.956	17.800	1.121	1.105
-1.6	-2.5242	1.0428	-4.1642	40.0196	-0.	-1.391	1.013	18.203	16.212	1.123	1.109
-1.4	-2.3218	1.0370	-4.3435	39.3654	-0.	-1.343	1.011	16.639	14.790	1.125	1.112
-1.2	-2.1197	1.0320	-4.4963	38.7352	-0.	-1.300	1.010	15.254	13.527	1.128	1.117
-1.0	-1.9176	1.0276	-4.6292	38.1292	-0.	-1.262	1.009	14.031	12.408	1.131	1.121
-0.8	-1.7163	1.0238	-4.7447	37.5413	-0.	-1.228	1.007	12.954	11.421	1.134	1.126
-0.6	-1.5145	1.0206	-4.8448	36.9705	-0.	-1.198	1.006	12.011	10.554	1.138	1.131
-0.4	-1.3137	1.0177	-4.9316	36.4144	-0.	-1.172	1.006	11.185	9.794	1.142	1.136
-0.2	-1.1126	1.0153	-5.0067	35.8712	-0.	-1.149	1.005	10.465	9.130	1.146	1.141
0.	-0.9117	1.0132	-5.0716	35.3392	-0.	-1.130	1.004	9.838	8.551	1.151	1.146
0.2	-0.7104	1.0114	-5.1278	34.8169	-0.	-1.112	1.004	9.293	8.047	1.155	1.151
0.4	-0.5102	1.0095	-5.1763	34.3030	-0.	-1.097	1.003	8.820	7.609	1.159	1.156
0.6	-0.3077	1.0084	-5.2192	33.7965	-0.	-1.084	1.003	8.409	7.228	1.164	1.160
0.8	-0.1072	1.0073	-5.2543	33.2962	-0.	-1.073	1.002	8.053	6.898	1.168	1.165
1.0	0.0913	1.0062	-5.2855	32.8014	-0.	-1.063	1.002	7.746	6.611	1.172	1.169
1.2	0.2710	1.0054	-5.3124	32.3113	-0.	-1.054	1.002	7.479	6.364	1.175	1.173
1.4	0.4420	1.0046	-5.3356	31.8252	-0.	-1.047	1.002	7.249	6.150	1.179	1.177
1.6	0.6022	1.0040	-5.3557	31.3426	-0.	-1.040	1.001	7.049	5.964	1.182	1.180
1.8	0.7525	1.0034	-5.3730	30.8631	-0.	-1.035	1.001	6.877	5.804	1.185	1.184
2.0	0.9027	1.0030	-5.3876	30.3862	-0.	-1.030	1.001	6.728	5.665	1.188	1.187
T = 2400 K											
-5.0	-6.1023	1.4705	7.7841	61.6100	5.897	-1.405	1.016	20.833	18.002	1.158	1.140
-4.8	-5.8936	1.4440	7.4670	60.6403	5.549	-1.557	1.016	25.440	23.005	1.149	1.125
-4.6	-5.6836	1.4314	7.0383	59.6512	6.088	-1.730	1.028	32.691	28.524	1.146	1.115
-4.4	-5.4732	1.4107	6.5026	58.6410	6.223	-1.700	1.035	38.839	33.885	1.146	1.107
-4.2	-5.2656	1.3861	5.8674	57.6818	6.354	-2.063	1.041	44.017	38.351	1.148	1.103
-4.0	-5.0770	1.3586	5.1563	56.7384	6.480	-2.180	1.045	47.583	41.406	1.149	1.099
-3.8	-4.8976	1.3296	4.4021	56.3620	6.601	-2.250	1.048	49.332	42.907	1.150	1.097
-3.6	-4.6980	1.3006	3.6354	56.7920	6.718	-2.275	1.049	49.463	43.042	1.149	1.096
-3.4	-4.4683	1.2720	2.9820	51.6468	6.831	-2.265	1.048	48.379	42.153	1.148	1.095
-3.2	-4.2749	1.2447	2.1580	50.1442	6.940	-2.229	1.046	46.492	40.587	1.145	1.095
-3.0	-4.0249	1.2151	1.4771	49.0953	7.046	-2.174	1.044	44.139	38.613	1.143	1.095
-2.8	-3.7213	1.1854	0.8418	47.9042	7.148	-2.110	1.041	41.344	36.432	1.140	1.095
-2.6	-3.4135	1.1736	0.2553	46.7722	7.248	-2.040	1.039	38.855	34.150	1.138	1.095
-2.4	-3.1055	1.1537	-0.2822	45.6388	-0.	-1.967	1.036	36.151	31.843	1.135	1.096
-2.2	-2.7971	1.1357	-0.7719	44.5021	-0.	-1.892	1.033	33.496	29.561	1.133	1.097
-2.0	-2.4928	1.1194	-1.2153	43.3719	-0.	-1.817	1.030	30.925	27.336	1.131	1.098
-1.8	-2.1971	1.1048	-1.5149	42.2078	-0.	-1.744	1.027	28.487	25.195	1.130	1.100
-1.6	-1.9020	1.0916	-1.7711	41.0438	-0.	-1.673	1.024	26.143	23.160	1.129	1.102
-1.4	-1.6073	1.0802	-2.0226	41.1242	-0.	-1.606	1.022	23.971	21.246	1.128	1.104
-1.2	-1.3132	1.0700	-2.2576	40.3453	-0.	-1.542	1.020	21.960	19.464	1.128	1.107
-1.0	-1.0205	1.0609	-2.4877	39.6036	-0.	-1.483	1.017	20.114	17.821	1.129	1.109
-0.8	-0.7262	1.0529	-2.7091	38.8955	-0.	-1.428	1.015	18.436	16.320	1.130	1.113
-0.6	-0.4313	1.0458	-2.9238	38.2175	-0.	-1.378	1.014	16.920	14.959	1.131	1.116
-0.4	-0.1368	1.0398	-3.1444	37.5667	-0.	-1.334	1.012	15.559	13.733	1.133	1.120
-0.2	0.1585	1.0345	-3.3626	36.9400	-0.	-1.293	1.010	14.346	12.635	1.135	1.124
0.	0.4566	1.0299	-3.5737	36.3345	-0.	-1.256	1.009	13.269	11.653	1.138	1.128
0.2	0.7540	1.0258	-3.6070	35.7478	-0.	-1.224	1.008	12.317	10.792	1.141	1.132
0.4	1.0534	1.0223	-3.6056	35.1777	-0.	-1.195	1.007	11.478	10.028	1.145	1.137
0.6	1.3521	1.0193	-3.6912	34.6221	-0.	-1.170	1.006	10.742	9.355	1.148	1.141
0.8	1.6510	1.0166	-3.6654	34.0791	-0.	-1.148	1.005	10.097	8.765	1.152	1.146
1.0	1.9500	1.0143	-3.6297	33.5471	-0.	-1.128	1.005	9.534	8.249	1.156	1.151
1.2	2.2490	1.0124	-3.5855	33.0247	-0.	-1.111	1.004	9.043	7.798	1.160	1.155
1.4	2.5480	1.0107	-3.5337	32.5106	-0.	-1.096	1.003	8.610	7.405	1.164	1.160
1.6	2.8470	1.0092	-3.4754	32.0038	-0.	-1.084	1.003	8.244	7.063	1.167	1.164
1.8	3.1460	1.0080	-3.4115	31.5033	-0.	-1.072	1.003	7.921	6.765	1.171	1.168
2.0	3.4450	1.0069	-3.3427	31.0092	-0.	-1.063	1.002	7.641	6.506	1.174	1.172

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^3 \text{ m/sec}$; and $M_u = 35.828$]

T = 2600 K												
$\log_{10} \frac{p}{p_0}$	$\log_{10} \frac{\rho}{\rho_0}$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_0$	$\frac{T(\frac{\partial p}{\partial T})_p}{p}$	$\frac{p(\frac{\partial p}{\partial T})_T}{T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A_0}{A}$
-5.0	-6.1458	1.4632	8.1574	62.6484	6.436	-1.071	1.003	8.121	6.424	1.264	1.260	3.565
-4.5	-5.6450	1.4606	8.0980	51.9054	6.584	-1.106	1.005	9.338	7.534	1.239	1.234	3.524
-4.0	-5.1479	1.4768	8.0064	41.1367	6.732	-1.158	1.007	11.139	9.171	1.215	1.206	3.480
-3.5	-4.6462	1.4712	7.8785	30.3269	6.878	-1.233	1.010	13.709	11.496	1.192	1.181	3.437
-3.0	-4.1458	1.4631	7.6852	19.4619	7.023	-1.334	1.014	17.192	14.626	1.175	1.159	3.395
-2.5	-3.6405	1.4518	7.4239	8.5253	7.186	-1.463	1.020	21.592	18.545	1.164	1.142	3.357
-2.0	-3.1359	1.4367	7.0650	57.5028	7.306	-1.614	1.026	26.658	23.010	1.159	1.129	3.321
-1.5	-2.6301	1.4174	6.6115	56.3504	7.442	-1.773	1.033	31.836	27.520	1.157	1.120	3.286
-1.0	-2.1247	1.3944	6.0626	55.1937	7.574	-1.920	1.039	36.419	31.471	1.157	1.114	3.250
-0.5	-1.6197	1.3683	5.4391	53.9339	7.701	-2.036	1.043	39.799	34.364	1.158	1.110	3.214
0.0	-1.1147	1.3403	4.7677	52.6338	7.824	-2.111	1.046	41.708	35.999	1.159	1.107	3.177
0.5	-0.6097	1.3116	4.0771	51.3376	7.942	-2.145	1.047	42.227	36.464	1.158	1.106	3.140
1.0	-0.1047	1.2833	3.3915	50.0544	8.056	-2.146	1.047	41.659	36.017	1.157	1.105	3.104
1.5	0.4003	1.2561	2.7281	48.8065	8.166	-2.121	1.046	40.352	34.950	1.155	1.104	3.070
2.0	0.9053	1.2303	2.0573	47.6037	8.273	-2.079	1.044	38.600	33.504	1.152	1.104	3.038
2.5	1.4103	1.2053	1.5067	46.4516	8.377	-2.028	1.042	36.608	31.847	1.150	1.104	3.009
3.0	1.9153	1.1814	0.9570	45.3515	8.478	-1.969	1.039	34.501	30.082	1.147	1.104	2.981
3.5	2.4203	1.1586	0.4499	44.3038	8.576	-1.907	1.036	32.357	28.271	1.145	1.104	2.956
4.0	2.9253	1.1358	-0.0156	43.3069	8.673	-1.843	1.034	30.219	26.454	1.142	1.105	2.933
4.5	3.4303	1.1129	-0.4399	42.3590	8.767	-1.779	1.031	28.120	24.658	1.140	1.106	2.913
5.0	3.9353	1.0900	-0.8649	41.4631	8.860	-1.714	1.028	26.084	22.904	1.139	1.108	2.895
5.5	4.4403	1.0671	-1.2899	40.6104	8.952	-1.651	1.026	24.132	21.212	1.138	1.109	2.879
6.0	4.9453	1.0442	-1.7149	39.8061	9.044	-1.589	1.023	22.282	19.599	1.137	1.111	2.866
6.5	5.4503	1.0213	-2.1399	39.0518	9.136	-1.530	1.021	20.548	18.079	1.137	1.113	2.854
7.0	5.9553	1.0000	-2.5649	38.3475	9.228	-1.475	1.019	18.939	16.661	1.137	1.116	2.845
7.5	6.4603	0.9787	-2.9899	37.6932	9.320	-1.424	1.016	17.460	15.351	1.137	1.119	2.837
8.0	6.9653	0.9574	-3.4149	37.0889	9.412	-1.376	1.015	16.112	14.152	1.139	1.122	2.831
8.5	7.4703	0.9361	-3.8399	36.5346	9.504	-1.332	1.013	14.893	13.063	1.140	1.126	2.826
9.0	7.9753	0.9148	-4.2649	35.9803	9.596	-1.293	1.011	13.797	12.082	1.142	1.129	2.823
9.5	8.4803	0.8935	-4.6899	35.5260	9.688	-1.257	1.010	12.819	11.202	1.144	1.133	2.821
10.0	8.9853	0.8722	-5.1149	35.1717	9.780	-1.226	1.009	11.949	10.417	1.147	1.137	2.820
1.0	0.0052	1.0285	-2.8748	34.4021	-0.	-1.197	1.008	11.179	9.721	1.150	1.141	2.820
1.2	0.2108	1.0247	-3.0830	33.8293	-0.	-1.172	1.007	10.500	9.106	1.153	1.146	2.821
1.4	0.4122	1.0214	-3.1759	33.7216	-0.	-1.150	1.006	9.904	8.564	1.156	1.150	2.822
1.6	0.6135	1.0185	-3.2513	33.7234	-0.	-1.131	1.005	9.380	8.088	1.160	1.154	2.823
1.8	0.8145	1.0160	-3.3170	33.7269	-0.	-1.114	1.004	8.922	7.670	1.163	1.158	2.826
2.0	1.0155	1.0133	-3.3739	33.6680	-0.	-1.098	1.003	8.524	7.312	1.167	1.163	2.830
2.2	1.2165	1.0104	-3.4299	33.6137	-0.	-1.082	1.002	8.186	6.997	1.171	1.167	2.834
2.4	1.4175	1.0075	-3.4859	33.5600	-0.	-1.066	1.001	7.900	6.724	1.175	1.171	2.838
2.6	1.6185	1.0046	-3.5419	33.5063	-0.	-1.050	1.000	7.664	6.492	1.179	1.175	2.842
2.8	1.8195	1.0017	-3.5979	33.4526	-0.	-1.034	1.000	7.468	6.300	1.183	1.179	2.846
3.0	2.0205	0.9988	-3.6539	33.3989	-0.	-1.018	1.000	7.302	6.144	1.187	1.183	2.850
3.2	2.2215	0.9959	-3.7099	33.3452	-0.	-1.002	1.000	7.166	6.018	1.191	1.187	2.854
3.4	2.4225	0.9930	-3.7659	33.2915	-0.	-0.986	1.000	7.060	5.912	1.195	1.191	2.858
3.6	2.6235	0.9901	-3.8219	33.2378	-0.	-0.970	1.000	6.974	5.826	1.199	1.195	2.862
3.8	2.8245	0.9872	-3.8779	33.1841	-0.	-0.954	1.000	6.908	5.760	1.203	1.199	2.866
4.0	3.0255	0.9843	-3.9339	33.1304	-0.	-0.938	1.000	6.862	5.704	1.207	1.203	2.870
4.2	3.2265	0.9814	-3.9899	33.0767	-0.	-0.922	1.000	6.826	5.658	1.211	1.207	2.874
4.4	3.4275	0.9785	-4.0459	33.0230	-0.	-0.906	1.000	6.800	5.622	1.215	1.211	2.878
4.6	3.6285	0.9756	-4.1019	32.9693	-0.	-0.890	1.000	6.784	5.596	1.219	1.215	2.882
4.8	3.8295	0.9727	-4.1579	32.9156	-0.	-0.874	1.000	6.798	5.580	1.223	1.219	2.886
5.0	4.0305	0.9698	-4.2139	32.8619	-0.	-0.858	1.000	6.822	5.574	1.227	1.223	2.890
5.2	4.2315	0.9669	-4.2699	32.8082	-0.	-0.842	1.000	6.866	5.598	1.231	1.227	2.894
5.4	4.4325	0.9640	-4.3259	32.7545	-0.	-0.826	1.000	6.920	5.642	1.235	1.231	2.898
5.6	4.6335	0.9611	-4.3819	32.7008	-0.	-0.810	1.000	7.004	5.696	1.239	1.235	2.902
5.8	4.8345	0.9582	-4.4379	32.6471	-0.	-0.794	1.000	7.108	5.760	1.243	1.239	2.906
6.0	5.0355	0.9553	-4.4939	32.5934	-0.	-0.778	1.000	7.232	5.834	1.247	1.243	2.910
6.2	5.2365	0.9524	-4.5499	32.5397	-0.	-0.762	1.000	7.376	5.918	1.251	1.247	2.914
6.4	5.4375	0.9495	-4.6059	32.4860	-0.	-0.746	1.000	7.540	6.012	1.255	1.251	2.918
6.6	5.6385	0.9466	-4.6619	32.4323	-0.	-0.730	1.000	7.724	6.116	1.259	1.255	2.922
6.8	5.8395	0.9437	-4.7179	32.3786	-0.	-0.714	1.000	7.928	6.230	1.263	1.259	2.926
7.0	6.0405	0.9408	-4.7739	32.3249	-0.	-0.698	1.000	8.152	6.354	1.267	1.263	2.930
7.2	6.2415	0.9379	-4.8299	32.2712	-0.	-0.682	1.000	8.396	6.488	1.271	1.267	2.934
7.4	6.4425	0.9350	-4.8859	32.2175	-0.	-0.666	1.000	8.660	6.632	1.275	1.271	2.938
7.6	6.6435	0.9321	-4.9419	32.1638	-0.	-0.650	1.000	8.924	6.786	1.279	1.275	2.942
7.8	6.8445	0.9292	-4.9979	32.1101	-0.	-0.634	1.000	9.208	6.950	1.283	1.279	2.946
8.0	7.0455	0.9263	-5.0539	32.0564	-0.	-0.618	1.000	9.502	7.124	1.287	1.283	2.950
8.2	7.2465	0.9234	-5.1099	32.0027	-0.	-0.602	1.000	9.816	7.308	1.291	1.287	2.954
8.4	7.4475	0.9205	-5.1659	31.9490	-0.	-0.586	1.000	10.140	7.502	1.295	1.291	2.958
8.6	7.6485	0.9176	-5.2219	31.8953	-0.	-0.570	1.000	10.484	7.706	1.299	1.295	2.962
8.8	7.8495	0.9147	-5.2779	31.8416	-0.	-0.554	1.000	10.848	7.920	1.303	1.299	2.966
9.0	8.0505	0.9118	-5.3339	31.7879	-0.	-0.538	1.000	11.232	8.144	1.307	1.303	2.970
9.2	8.2515	0.9089	-5.3899	31.7342	-0.	-0.522	1.000	11.636	8.378	1.311	1.307	2.974
9.4	8.4525	0.9060	-5.4459	31.6805	-0.	-0.506	1.000	12.060	8.622	1.315	1.311	2.978
9.6	8.6535	0.9031	-5.5019	31.6268	-0.	-0.490	1.000	12.504	8.876	1.319	1.315	2.982
9.8	8.8545	0.9002	-5.5579	31.5731	-0.	-0.474	1.000	12.968	9.140	1.323	1.319	2.986
10.0	9.0555	0.8973	-5.6139	31.5194	-0.	-0.458	1.000	13.452	9.414	1.327	1.323	2.990
10.2	9.2565	0.8944	-5.6699	31.4657	-0.	-0.442	1.000	13.956	9.698	1.331	1.327	2.994
10.4	9.4575	0.8915	-5.7259	31.4120	-0.	-0.426	1.000	14.480	9.992	1.335	1.331	2.998
10.6	9.6585	0.										

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING
MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$;
 $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 3000 K													
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} n_e$	$\frac{T}{\rho} \left(\frac{\partial p}{\partial T} \right)_p$	$\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p} \right)_T$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$	
-5.0	-6.2136	1.4697	7.6967	63.6335	7.422	-1.030	1.001	7.23d	5.659	1.279	1.278	3.864	
-4.8	-6.0136	1.4891	7.6677	62.9286	7.572	-1.027	1.001	6.997	5.429	1.289	1.288	3.878	
-4.6	-5.8135	1.4984	7.6504	62.2257	7.722	-1.026	1.001	6.843	5.279	1.296	1.295	3.889	
-4.4	-5.6135	1.4678	7.6350	61.5230	7.872	-1.026	1.001	6.774	5.208	1.301	1.299	3.894	
-4.2	-5.4130	1.4669	7.6141	60.8192	8.022	-1.030	1.001	6.815	5.239	1.301	1.299	3.893	
-4.0	-5.2127	1.4859	7.6914	60.1121	8.171	-1.038	1.002	6.979	5.381	1.297	1.295	3.885	
-3.8	-5.0123	1.4844	7.6518	59.3995	8.320	-1.051	1.003	7.312	5.677	1.288	1.285	3.868	
-3.6	-4.8117	1.4824	7.6211	58.6745	8.469	-1.071	1.004	7.881	6.127	1.274	1.269	3.842	
-3.4	-4.6108	1.4794	7.631	57.9346	8.617	-1.102	1.005	8.778	6.990	1.256	1.249	3.808	
-3.2	-4.4096	1.4752	7.6794	57.1704	8.765	-1.146	1.007	10.120	8.191	1.235	1.226	3.767	
-3.0	-4.2078	1.4651	7.5590	56.3719	8.911	-1.212	1.011	12.030	9.894	1.216	1.203	3.724	
-2.8	-4.0052	1.4606	7.3881	55.5264	9.055	-1.299	1.015	14.596	12.167	1.200	1.182	3.680	
-2.6	-3.8017	1.44495	7.1525	54.6206	9.197	-1.408	1.020	17.795	14.979	1.180	1.164	3.638	
-2.4	-3.5971	1.4324	6.8407	53.6450	9.336	-1.534	1.026	21.417	18.130	1.181	1.151	3.598	
-2.2	-3.3912	1.4142	6.4494	52.5969	9.472	-1.663	1.033	25.046	21.260	1.177	1.141	3.558	
-2.0	-3.1841	1.3913	5.9814	51.4837	9.603	-1.780	1.038	28.196	23.951	1.178	1.134	3.518	
-1.8	-2.9761	1.3658	5.4565	50.3238	9.729	-1.870	1.042	30.467	25.486	1.177	1.129	3.479	
-1.6	-2.7674	1.3386	4.8957	49.1404	9.851	-1.927	1.045	31.713	26.957	1.176	1.126	3.439	
-1.4	-2.5583	1.3110	4.3216	47.9560	9.968	-1.951	1.046	32.022	27.250	1.175	1.124	3.400	
-1.2	-2.3482	1.2838	3.7530	46.7500	10.082	-1.950	1.045	31.621	26.953	1.173	1.122	3.362	
-1.0	-2.1403	1.2576	3.2025	45.5453	10.191	-1.930	1.044	30.749	26.263	1.171	1.121	3.326	
-0.8	-1.9316	1.2323	2.6784	44.3570	10.297	-1.898	1.042	29.601	25.333	1.168	1.121	3.292	
-0.6	-1.7244	1.2076	2.1842	43.2003	10.399	-1.859	1.040	28.304	24.285	1.165	1.120	3.261	
-0.4	-1.5156	1.1841	1.7220	42.0461	10.499	-1.815	1.038	26.933	23.160	1.163	1.120	3.232	
-0.2	-1.3082	1.1622	1.2922	40.9139	10.596	-1.769	1.036	25.526	21.997	1.160	1.121	3.205	
0.	-1.1014	1.1409	0.8950	40.8030	10.691	-1.720	1.033	24.106	20.812	1.158	1.121	3.180	
0.2	-0.8950	1.1191	0.5295	40.6918	10.782	-1.670	1.031	22.689	19.622	1.156	1.122	3.158	
0.4	-0.6881	1.0978	0.1954	39.5954	10.872	-1.620	1.028	21.290	18.439	1.155	1.123	3.138	
0.6	-0.4817	1.0766	-0.1045	38.5249	10.958	-1.565	1.026	19.926	17.276	1.153	1.124	3.121	
0.8	-0.2736	1.0556	-0.3824	37.4736	11.041	-1.519	1.023	18.610	16.148	1.152	1.126	3.105	
1.0	-0.0743	1.0304	-0.6308	36.4351	11.121	-1.471	1.021	17.356	15.067	1.152	1.128	3.092	
1.2	0.1257	1.0705	-0.8523	35.3794	11.197	-1.425	1.019	16.176	14.044	1.152	1.130	3.081	
1.4	0.3233	1.0617	-1.0497	35.0910	11.269	-1.381	1.017	15.077	13.087	1.152	1.133	3.072	
1.6	0.5265	1.0538	-1.2250	34.4287	11.336	-1.340	1.015	14.065	12.201	1.153	1.136	3.064	
1.8	0.7354	1.0469	-1.3801	33.7630	-0.	-1.302	1.013	13.139	11.387	1.154	1.139	3.058	
2.0	0.9419	1.0403	-1.5169	33.1725	-0.	-1.268	1.012	12.299	10.646	1.155	1.142	3.053	
T = 3200 K													
-5.0	-5.2422	1.4645	8.0111	64.1730	7.821	-1.080	1.002	9.955	8.220	1.211	1.209	3.888	
-4.8	-5.0423	1.4630	7.7619	63.4300	7.971	-1.065	1.002	9.115	7.425	1.228	1.225	3.912	
-4.6	-4.8423	1.4618	7.6218	62.7037	8.122	-1.053	1.002	8.453	6.601	1.243	1.241	3.936	
-4.4	-4.6422	1.4608	7.4818	61.9888	8.272	-1.045	1.001	7.943	6.018	1.257	1.255	3.957	
-4.2	-4.4419	1.4599	7.3420	61.2745	8.422	-1.039	1.001	7.562	5.557	1.270	1.268	3.976	
-4.0	-4.2416	1.4590	7.2025	60.5636	8.572	-1.035	1.001	7.236	5.202	1.280	1.278	3.990	
-3.8	-4.0414	1.4580	7.0623	59.8547	8.722	-1.035	1.001	7.140	5.349	1.287	1.285	4.000	
-3.6	-3.8411	1.4570	6.9221	59.1453	8.871	-1.037	1.002	7.101	5.504	1.290	1.288	4.003	
-3.4	-3.6407	1.4560	6.7818	58.4366	9.020	-1.044	1.002	7.199	5.583	1.290	1.287	4.000	
-3.2	-3.4402	1.4550	6.6415	57.7270	9.170	-1.057	1.003	7.471	5.819	1.284	1.280	3.987	
-3.0	-3.2395	1.4541	6.5013	57.0183	9.318	-1.077	1.004	7.974	6.264	1.273	1.268	3.965	
-2.8	-3.0389	1.4532	6.3610	56.3096	9.466	-1.107	1.006	8.789	6.986	1.258	1.251	3.933	
-2.6	-2.8381	1.4523	6.2207	55.6009	9.613	-1.153	1.008	10.010	8.075	1.240	1.230	3.895	
-2.4	-2.6373	1.4514	6.0804	54.8922	9.758	-1.216	1.012	11.756	9.612	1.223	1.209	3.852	
-2.2	-2.4364	1.4505	5.9401	54.1835	9.902	-1.300	1.016	14.063	11.638	1.208	1.189	3.809	
-2.0	-2.2357	1.4496	5.8000	53.4748	10.043	-1.404	1.021	16.887	14.099	1.198	1.173	3.766	
-1.8	-2.0348	1.4487	5.6598	52.7661	10.181	-1.520	1.027	20.004	16.791	1.191	1.160	3.724	
-1.6	-1.8339	1.4478	5.5195	52.0574	10.316	-1.636	1.033	23.043	19.393	1.188	1.150	3.682	
-1.4	-1.6330	1.4469	5.3792	51.3487	10.445	-1.738	1.038	25.588	21.559	1.187	1.143	3.641	
-1.2	-1.4321	1.4460	5.2389	50.6400	10.570	-1.813	1.042	27.348	23.057	1.186	1.138	3.599	
-1.0	-1.2312	1.4451	5.0986	49.9313	10.691	-1.858	1.044	28.244	23.835	1.185	1.135	3.558	
-0.8	-1.0303	1.4442	4.9583	49.2226	10.807	-1.875	1.045	28.385	23.990	1.183	1.132	3.518	
-0.6	-0.8294	1.4433	4.8180	48.5139	10.918	-1.870	1.044	27.973	23.688	1.181	1.131	3.480	
-0.4	-0.6285	1.4424	4.6777	47.8052	11.025	-1.850	1.043	27.208	23.001	1.178	1.130	3.443	
-0.2	-0.4276	1.4415	4.5374	47.0965	11.129	-1.821	1.041	26.240	22.322	1.176	1.129	3.409	
0.	-0.2267	1.4406	4.3971	46.3878	11.229	-1.786	1.039	25.164	21.457	1.173	1.128	3.377	
0.2	-0.0258	1.4397	4.2568	45.6791	11.326	-1.748	1.037	24.032	20.339	1.170	1.128	3.347	
0.4	0.1751	1.4388	4.1165	44.9704	11.419	-1.706	1.035	22.870	19.587	1.168	1.128	3.319	
0.6	0.3742	1.4379	3.9762	44.2617	11.508	-1.663	1.032	21.692	18.613	1.165	1.129	3.294	
0.8	0.5733	1.4370	3.8359	43.5530	11.593	-1.619	1.030	20.509	17.628	1.163	1.129	3.272	
1.0	0.7724	1.4361	3.6956	42.8443	11.674	-1.573	1.028	19.334	16.642	1.162	1.130	3.251	
1.2	0.9715	1.4352	3.5553	42.1356	11.750	-1.528	1.025	18.180	15.667	1.160	1.132	3.233	
1.4	1.1706	1.4343	3.4150	41.4269	11.821	-1.483	1.023	17.060	14.715	1.159	1.133	3.217	
1.6	1.3697	1.4334	3.2747	40.7182	11.886	-1.439	1.021	15.988	13.798	1.159	1.135	3.204	
1.8	1.5688	1.4325	3.1344	40.0095	11.944	-1.396	1.019	14.974	12.925	1.159	1.137	3.192	
2.0	1.7679	1.4316	2.9941	39.3008	11.996	-1.356	1.017	14.026	12.105	1.159	1.139	3.182	

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING
MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[50% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$;
 $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_H = 35.828$]

T = 3400 K													
$\log_{10} \frac{p}{p_0}$	$\log_{10} \frac{\rho}{\rho_0}$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_e$	$\frac{T(\theta p)}{\rho(\theta p)_T}$	$\frac{p(\theta p)}{\rho(\theta p)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$	$\frac{\Lambda}{A_0}$
-5.0	-6.2751	1.5007	5.2929	64.9471	8.170	-1.210	1.000	16.510	14.318	1.153	1.146	3.918	
-4.9	-6.0720	1.5028	5.1627	64.1238	8.321	-1.168	1.005	14.332	12.291	1.166	1.160	3.937	
-4.8	-5.8711	1.4952	5.0585	63.3287	8.472	-1.135	1.004	12.596	10.670	1.180	1.176	3.959	
-4.7	-5.6704	1.4872	4.9740	62.5549	8.623	-1.109	1.003	11.215	9.380	1.196	1.192	3.983	
-4.6	-5.4694	1.4792	4.9075	61.7935	8.774	-1.088	1.003	10.123	8.357	1.211	1.208	4.007	
-4.5	-5.2693	1.4715	4.8520	61.0557	8.924	-1.072	1.002	9.265	7.552	1.227	1.224	4.032	
-4.4	-5.0688	1.4640	4.8078	60.3230	9.074	-1.060	1.002	8.600	6.927	1.242	1.239	4.054	
-4.3	-4.8685	1.4567	4.7694	59.5983	9.224	-1.052	1.002	8.100	6.455	1.255	1.253	4.075	
-4.2	-4.6681	1.4494	4.7364	58.8788	9.374	-1.047	1.002	7.743	6.113	1.267	1.264	4.092	
-4.1	-4.4677	1.4421	4.7093	58.1621	9.524	-1.045	1.002	7.522	5.899	1.275	1.273	4.103	
-4.0	-4.2673	1.4347	4.6739	57.4458	9.674	-1.048	1.002	7.441	5.812	1.280	1.277	4.109	
-3.9	-4.0668	1.4274	4.6393	56.7267	9.823	-1.055	1.003	7.518	5.869	1.281	1.277	4.106	
-3.8	-3.8661	1.4201	4.6047	56.0017	9.972	-1.069	1.004	7.791	6.102	1.277	1.272	4.095	
-3.7	-3.6652	1.4128	4.5701	55.2765	10.120	-1.092	1.005	8.315	6.560	1.268	1.261	4.073	
-3.6	-3.4640	1.4055	4.5356	54.5511	10.267	-1.127	1.007	9.167	7.307	1.255	1.246	4.042	
-3.5	-3.2623	1.4005	4.5010	53.8259	10.413	-1.177	1.010	10.433	8.418	1.239	1.227	4.004	
-3.4	-3.0608	1.3954	4.4664	53.1007	10.558	-1.246	1.014	12.180	9.944	1.225	1.208	3.962	
-3.3	-2.8594	1.3903	4.4318	52.3755	10.703	-1.333	1.019	14.407	11.879	1.213	1.190	3.918	
-3.2	-2.6577	1.3852	4.3972	51.6503	10.848	-1.435	1.025	16.994	14.109	1.204	1.176	3.874	
-3.1	-2.4557	1.3801	4.3626	50.9251	10.993	-1.543	1.030	19.672	16.398	1.200	1.164	3.831	
-3.0	-2.2541	1.3750	4.3280	50.2000	11.138	-1.643	1.036	22.087	18.450	1.197	1.156	3.788	
-2.9	-2.0524	1.3699	4.2934	49.4748	11.283	-1.723	1.040	23.928	20.012	1.196	1.150	3.745	
-2.8	-1.8507	1.3648	4.2588	48.7496	11.428	-1.777	1.043	25.041	20.966	1.194	1.145	3.702	
-2.7	-1.6490	1.3597	4.2242	48.0244	11.573	-1.803	1.044	25.435	21.346	1.193	1.142	3.660	
-2.6	-1.4473	1.3546	4.1896	47.2992	11.718	-1.807	1.044	25.319	21.273	1.190	1.140	3.620	
-2.5	-1.2456	1.3495	4.1550	46.5740	11.863	-1.796	1.043	24.810	20.893	1.187	1.139	3.581	
-2.4	-1.0439	1.3444	4.1204	45.8488	12.008	-1.773	1.041	24.079	20.327	1.185	1.137	3.545	
-2.3	-0.8422	1.3393	4.0858	45.1236	12.153	-1.744	1.040	23.226	19.656	1.182	1.137	3.511	
-2.2	-0.6405	1.3342	4.0512	44.3984	12.298	-1.712	1.038	22.310	18.926	1.179	1.136	3.479	
-2.1	-0.4388	1.3291	4.0166	43.6732	12.443	-1.677	1.036	21.357	18.158	1.176	1.136	3.449	
-2.0	-0.2371	1.3240	3.9820	42.9480	12.588	-1.639	1.033	20.380	17.364	1.174	1.136	3.422	
-1.9	-0.0354	1.3189	3.9474	42.2228	12.733	-1.600	1.031	19.388	16.550	1.171	1.136	3.397	
-1.8	-0.1663	1.3138	3.9128	41.4976	12.878	-1.560	1.029	18.389	15.723	1.170	1.137	3.375	
-1.7	0.0354	1.3087	3.8782	40.7724	13.023	-1.519	1.027	17.393	14.893	1.168	1.138	3.355	
-1.6	0.2371	1.3036	3.8436	40.0472	13.168	-1.478	1.024	16.414	14.070	1.167	1.139	3.337	
-1.5	0.4388	1.2985	3.8090	39.3220	13.313	-1.437	1.022	15.463	13.266	1.166	1.140	3.321	
-1.4	0.6405	1.2934	3.7744	38.5968	13.458								
-1.3	0.8422	1.2883	3.7398	37.8716	13.603								
-1.2	1.0439	1.2832	3.7052	37.1464	13.748								
-1.1	1.2456	1.2781	3.6706	36.4212	13.893								
-1.0	1.4473	1.2730	3.6360	35.6960	14.038								
-0.9	1.6490	1.2679	3.6014	34.9708	14.183								
-0.8	1.8507	1.2628	3.5668	34.2456	14.328								
-0.7	2.0524	1.2577	3.5322	33.5204	14.473								
-0.6	2.2541	1.2526	3.4976	32.7952	14.618								
-0.5	2.4557	1.2475	3.4630	32.0700	14.763								
-0.4	2.6577	1.2424	3.4284	31.3448	14.908								
-0.3	2.8594	1.2373	3.3938	30.6196	15.053								
-0.2	3.0608	1.2322	3.3592	29.8944	15.198								
-0.1	3.2623	1.2271	3.3246	29.1692	15.343								
0.0	3.4640	1.2220	3.2900	28.4440	15.488								
0.1	3.6652	1.2169	3.2554	27.7188	15.633								
0.2	3.8661	1.2118	3.2208	26.9936	15.778								
0.3	4.0673	1.2067	3.1862	26.2684	15.923								
0.4	4.2685	1.2016	3.1516	25.5432	16.068								
0.5	4.4694	1.1965	3.1170	24.8180	16.213								
0.6	4.6704	1.1914	3.0824	24.0928	16.358								
0.7	4.8711	1.1863	3.0478	23.3676	16.503								
0.8	5.0719	1.1812	3.0132	22.6424	16.648								
0.9	5.2727	1.1761	2.9786	21.9172	16.793								
1.0	5.4735	1.1710	2.9440	21.1920	16.938								
1.1	5.6743	1.1659	2.9094	20.4668	17.083								
1.2	5.8751	1.1608	2.8748	19.7416	17.228								
1.3	6.0759	1.1557	2.8402	19.0164	17.373								
1.4	6.2767	1.1506	2.8056	18.2912	17.518								
1.5	6.4775	1.1455	2.7710	17.5660	17.663								
1.6	6.6783	1.1404	2.7364	16.8408	17.808								
1.7	6.8791	1.1353	2.7018	16.1156	17.953								
1.8	7.0799	1.1302	2.6672	15.3904	18.098								
1.9	7.2807	1.1251	2.6326	14.6652	18.243								
2.0	7.4815	1.1200	2.5980	13.9400	18.388								

T = 3600 K

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 3800 K													
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_e$	$\frac{T(p_0)}{p(p_0)_T}$	$\frac{p(p_0)}{p(p_0)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$	$\frac{\Delta}{A_0}$
-5.0	-6.2466	1.5967	10.7954	68.4787	8.760	-2.004	1.032	55.519	49.308	1.126	1.091	4.160	
-4.8	-6.1407	1.5752	10.1342	67.0832	8.903	-1.823	1.027	45.893	40.795	1.125	1.096	4.141	
-4.6	-6.0359	1.5578	9.5975	65.9252	9.053	-1.670	1.022	38.022	33.768	1.126	1.102	4.130	
-4.4	-5.9320	1.5437	9.1656	64.6794	9.204	-1.544	1.018	31.628	28.014	1.129	1.109	4.125	
-4.2	-5.8288	1.5324	8.8191	63.6246	9.357	-1.439	1.014	26.463	23.334	1.134	1.118	4.126	
-4.0	-5.7262	1.5234	8.5414	62.6435	9.509	-1.354	1.012	22.308	19.547	1.141	1.128	4.132	
-3.8	-5.6241	1.5161	8.3192	61.7216	9.662	-1.285	1.009	18.977	16.497	1.150	1.140	4.144	
-3.6	-5.5224	1.5102	8.1410	60.8465	9.814	-1.229	1.006	16.313	14.048	1.161	1.152	4.159	
-3.4	-5.4210	1.5054	7.9963	60.0097	9.965	-1.185	1.006	14.192	12.091	1.174	1.166	4.177	
-3.2	-5.3199	1.5015	7.8834	59.2024	10.116	-1.150	1.005	12.508	10.534	1.187	1.181	4.198	
-3.0	-5.2190	1.4983	7.7903	58.4186	10.267	-1.122	1.004	11.181	9.302	1.202	1.197	4.221	
-2.8	-5.1182	1.4956	7.7141	57.6530	10.418	-1.101	1.004	10.145	8.339	1.217	1.212	4.244	
-2.6	-5.0175	1.4932	7.6503	56.9011	10.568	-1.086	1.003	9.334	7.599	1.231	1.227	4.266	
-2.4	-4.9168	1.4909	7.5954	56.1588	10.718	-1.076	1.003	8.772	7.052	1.244	1.240	4.286	
-2.2	-4.8162	1.4887	7.5455	55.4227	10.868	-1.071	1.003	8.382	6.680	1.255	1.251	4.301	
-2.0	-4.7155	1.4863	7.4970	54.6893	11.017	-1.072	1.004	8.179	6.477	1.263	1.258	4.310	
-1.8	-4.6147	1.4835	7.4457	53.9542	11.166	-1.080	1.005	8.176	6.455	1.267	1.261	4.311	
-1.6	-4.5136	1.4800	7.3960	53.2127	11.314	-1.096	1.006	8.403	6.636	1.266	1.259	4.303	
-1.4	-4.4122	1.4754	7.3432	52.4688	11.461	-1.122	1.008	8.906	7.061	1.261	1.252	4.284	
-1.2	-4.3105	1.4693	7.2777	51.6851	11.607	-1.162	1.010	9.740	7.776	1.253	1.240	4.255	
-1.0	-4.2091	1.4612	7.0906	50.8831	11.751	-1.218	1.014	10.952	8.815	1.242	1.225	4.218	
-0.8	-4.1084	1.4503	6.9218	50.0438	11.893	-1.289	1.019	12.541	10.175	1.233	1.210	4.176	
-0.6	-4.0086	1.4362	6.7023	49.1594	12.032	-1.373	1.024	14.420	11.780	1.225	1.196	4.132	
-0.4	-3.9093	1.4187	6.4274	48.2270	12.167	-1.464	1.029	16.415	13.463	1.219	1.184	4.086	
-0.2	-3.8100	1.3980	6.0987	47.2496	12.298	-1.549	1.035	18.250	15.009	1.216	1.175	4.041	
0.	-3.7115	1.3745	5.7252	46.2377	12.425	-1.618	1.039	19.690	16.224	1.214	1.168	3.995	
0.2	-3.6135	1.3483	5.2213	45.2065	12.546	-1.666	1.041	20.504	17.006	1.212	1.163	3.949	
0.4	-3.5151	1.3234	4.7025	44.1724	12.661	-1.691	1.043	20.938	17.365	1.209	1.160	3.905	
0.6	-3.4165	1.2978	4.1820	43.1402	12.772	-1.697	1.043	20.568	17.382	1.206	1.157	3.862	
0.8	-3.3177	1.2715	3.6720	42.1455	12.877	-1.689	1.042	20.651	17.165	1.203	1.155	3.821	
1.0	-3.2188	1.2436	3.1644	41.1704	12.976	-1.673	1.040	20.162	16.805	1.200	1.153	3.782	
1.2	-3.1199	1.2140	2.6593	40.2237	13.069	-1.651	1.039	19.579	16.363	1.197	1.152	3.746	
1.4	-3.0209	1.1828	2.1542	39.3070	13.157	-1.626	1.037	18.945	15.875	1.193	1.151	3.712	
1.6	-2.9219	1.1495	1.6491	38.4201	13.237	-1.598	1.035	18.280	15.357	1.190	1.150	3.680	
1.8	-2.8229	1.1145	1.1440	37.5628	13.311	-1.565	1.033	17.591	14.812	1.188	1.150	3.650	
2.0	-2.7239	1.0783	0.6389	36.7345	13.377	-1.538	1.031	16.880	14.243	1.185	1.149	3.623	
T = 4000 K													
-5.0	-6.2954	1.7131	14.0169	72.3240	9.152	-2.787	1.060	97.939	85.385	1.147	1.083	4.404	
-4.8	-6.1864	1.7022	12.7342	70.2627	9.234	-2.511	1.051	81.239	71.265	1.141	1.086	4.355	
-4.6	-6.0774	1.6898	11.6319	68.4446	9.341	-2.260	1.042	67.070	59.062	1.136	1.089	4.316	
-4.4	-5.9684	1.6759	10.6825	66.8482	9.469	-2.039	1.035	55.232	48.781	1.132	1.094	4.286	
-4.2	-5.8594	1.6620	9.8428	65.4228	9.609	-1.851	1.029	45.525	40.258	1.131	1.099	4.265	
-4.0	-5.7504	1.6481	9.0742	64.1418	9.757	-1.692	1.024	37.637	32.264	1.131	1.105	4.252	
-3.8	-5.6414	1.6342	8.3313	62.9746	9.909	-1.561	1.019	31.267	27.567	1.134	1.113	4.245	
-3.6	-5.5324	1.6203	7.6129	61.9102	10.060	-1.453	1.016	26.144	22.952	1.139	1.122	4.245	
-3.4	-5.4234	1.6064	6.9182	60.9182	10.212	-1.365	1.013	22.037	19.229	1.146	1.132	4.250	
-3.2	-5.3144	1.5925	6.2563	59.9877	10.364	-1.294	1.010	18.755	16.239	1.155	1.143	4.261	
-3.0	-5.2054	1.5786	5.6221	59.1060	10.516	-1.237	1.008	16.140	13.846	1.166	1.156	4.275	
-2.8	-5.0964	1.5647	5.0142	58.2634	10.668	-1.192	1.007	14.063	11.939	1.178	1.170	4.294	
-2.6	-4.9874	1.5508	4.4251	57.4511	10.819	-1.156	1.006	12.423	10.477	1.191	1.185	4.314	
-2.4	-4.8784	1.5369	3.8562	56.6627	10.970	-1.129	1.005	11.139	9.239	1.206	1.200	4.336	
-2.2	-4.7694	1.5230	3.3073	55.8924	11.120	-1.108	1.004	10.149	8.320	1.220	1.214	4.358	
-2.0	-4.6604	1.5091	2.7784	55.1352	11.270	-1.094	1.004	9.411	7.631	1.233	1.228	4.379	
-1.8	-4.5514	1.4952	2.2695	54.3869	11.420	-1.087	1.004	8.896	7.144	1.245	1.240	4.396	
-1.6	-4.4424	1.4813	1.7806	53.6431	11.569	-1.086	1.005	8.593	6.849	1.255	1.249	4.407	
-1.4	-4.3334	1.4674	1.3117	52.9092	11.717	-1.092	1.005	8.508	6.749	1.261	1.254	4.411	
-1.2	-4.2244	1.4535	0.8628	52.1801	11.865	-1.107	1.007	8.603	6.862	1.262	1.254	4.405	
-1.0	-4.1154	1.4396	0.4339	51.4591	12.012	-1.133	1.009	9.096	7.220	1.260	1.249	4.388	
-0.8	-4.0064	1.4257	0.0250	50.7382	12.157	-1.173	1.012	9.848	7.854	1.254	1.240	4.361	
-0.6	-3.8974	1.4118	-0.3841	49.9900	12.301	-1.227	1.015	10.949	8.788	1.246	1.227	4.326	
-0.4	-3.7884	1.3979	-0.8130	48.9594	12.442	-1.296	1.020	12.380	10.000	1.238	1.214	4.285	
-0.2	-3.6794	1.3840	-1.2619	48.0750	12.579	-1.375	1.025	14.041	11.401	1.232	1.201	4.241	
0.	-3.5704	1.3701	-1.7310	47.1473	12.713	-1.458	1.031	15.746	12.834	1.227	1.191	4.195	
0.2	-3.4614	1.3562	-2.2201	46.1810	12.842	-1.533	1.035	17.266	14.108	1.224	1.182	4.148	
0.4	-3.3524	1.3423	-2.7292	45.1872	12.966	-1.592	1.039	18.408	15.071	1.221	1.175	4.101	
0.6	-3.2434	1.3284	-3.2583	44.1804	13.084	-1.631	1.041	19.089	15.660	1.219	1.171	4.055	
0.8	-3.1344	1.3145	-3.8074	43.1753	13.196	-1.649	1.042	19.335	15.899	1.216	1.167	4.010	
1.0	-3.0254	1.2996	-4.3765	42.1837	13.303	-1.651	1.042	19.247	15.868	1.213	1.164	3.966	
1.2	-2.9164	1.2857	-4.9656	41.2134	13.403	-1.651	1.041	18.938	15.658	1.209	1.162	3.925	
1.4	-2.8074	1.2718	-5.5747	40.2690	13.496	-1.625	1.040	18.501	15.342	1.206	1.160	3.885	
1.6	-2.6984	1.2579	-6.2038	39.3521	13.582	-1.604	1.038	17.997	14.966	1.203	1.159	3.848	
1.8	-2.5894	1.2440	-6.8529	38.4633	13.661	-1.581	1.036	17.455	14.555	1.199	1.157	3.814	
2.0	-2.4804	1.2301	-7.5220	37.6023	13.732	-1.557	1.034	16.897	14.118	1.196	1.156	3.781	

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; p₀ = 1.01325 × 10⁵ N/m²; ρ₀ = 1.59842 kg/m³; R = 8.31469 J/mole-°K;A₀ = 2.97904 × 10² m/sec; and M_u = 35.828]

T = 4200 K													
log ₁₀ p/p ₀	log ₁₀ ρ/ρ ₀	Z	H RT	S R	log ₁₀ N _e	T (θ ₀ /T) _p	p (θ ₀ /T) _T	C _p R	C _v R	γ	γ _E	A A ₀	
-5.0	-6.4671	1.9066	19.2688	78.3785	9.686	-3.534	1.086	148.786	126.868	1.173	1.080	4.755	
-4.9	-6.2504	1.8349	17.1666	75.4151	9.727	-3.333	1.080	131.337	112.459	1.168	1.081	4.668	
-4.6	-6.0353	1.7718	15.3370	72.7554	9.773	-3.066	1.071	112.201	96.655	1.161	1.083	4.592	
-4.4	-5.8219	1.7182	13.7536	70.4039	9.833	-2.776	1.062	93.777	81.310	1.153	1.086	4.527	
-4.2	-5.6105	1.6736	12.5184	68.3528	9.916	-2.494	1.052	77.397	67.508	1.146	1.089	4.475	
-4.0	-5.4009	1.6711	11.4793	66.5519	10.023	-2.230	1.044	63.530	55.670	1.141	1.093	4.434	
-3.8	-5.1930	1.6704	10.6394	64.9652	10.150	-2.017	1.036	52.105	45.795	1.138	1.098	4.403	
-3.6	-4.9864	1.6534	9.9637	63.5549	10.290	-1.829	1.030	42.830	37.686	1.137	1.104	4.381	
-3.4	-4.7811	1.6640	9.4219	62.2884	10.437	-1.672	1.024	35.363	31.091	1.137	1.111	4.368	
-3.2	-4.5765	1.6455	8.9878	61.1379	10.587	-1.543	1.020	29.377	25.759	1.140	1.119	4.362	
-3.0	-4.3732	1.5760	8.6403	60.0809	10.739	-1.438	1.016	24.596	21.468	1.146	1.128	4.362	
-2.6	-4.1704	1.5259	8.3631	59.0932	10.852	-1.353	1.013	20.783	18.024	1.153	1.138	4.368	
-2.5	-3.9681	1.5178	8.1406	58.1750	11.044	-1.285	1.010	17.750	15.271	1.162	1.150	4.379	
-2.4	-3.7662	1.5112	7.9619	57.2997	11.195	-1.230	1.009	15.345	13.077	1.173	1.163	4.394	
-2.2	-3.5646	1.5057	7.8177	56.4599	11.347	-1.187	1.007	13.447	11.339	1.186	1.177	4.413	
-2.0	-3.3633	1.5012	7.7002	55.6500	11.497	-1.154	1.006	11.961	9.973	1.199	1.192	4.433	
-1.9	-3.1621	1.4572	7.5928	54.8622	11.648	-1.130	1.005	10.814	8.914	1.213	1.207	4.454	
-1.8	-2.9611	1.4936	7.5200	54.0910	11.798	-1.113	1.005	9.956	8.116	1.227	1.220	4.474	
-1.6	-2.7600	1.4900	7.4465	53.1305	11.947	-1.103	1.005	9.350	7.547	1.239	1.233	4.491	
-1.2	-2.5550	1.4864	7.3774	52.5750	12.096	-1.101	1.006	8.982	7.191	1.249	1.242	4.503	
-1.0	-2.3578	1.4823	7.3071	51.8222	12.245	-1.107	1.007	8.852	7.047	1.256	1.248	4.507	
-0.8	-2.1563	1.4774	7.2296	51.0631	12.392	-1.123	1.008	8.978	7.130	1.259	1.249	4.502	
-0.6	-1.9545	1.4712	7.1377	50.2920	12.538	-1.150	1.010	9.390	7.462	1.258	1.245	4.486	
-0.4	-1.7522	1.4632	7.0232	49.5017	12.682	-1.191	1.013	10.115	8.065	1.254	1.237	4.459	
-0.2	-1.5491	1.4529	6.8770	48.5840	12.824	-1.247	1.017	11.160	8.941	1.248	1.227	4.424	
0.	-1.3451	1.4367	6.6910	47.8317	12.964	-1.314	1.022	12.477	10.045	1.242	1.215	4.383	
0.2	-1.1401	1.4233	6.4854	46.9409	13.099	-1.389	1.028	13.945	11.271	1.237	1.204	4.338	
0.4	-0.9341	1.4037	6.1817	46.0121	13.230	-1.463	1.033	15.374	12.463	1.234	1.195	4.292	
0.6	-0.7272	1.3814	5.8636	45.0526	13.355	-1.527	1.037	16.570	13.663	1.231	1.187	4.244	
0.8	-0.5195	1.3572	5.5158	44.0742	13.475	-1.573	1.040	17.397	14.166	1.228	1.181	4.196	
1.0	-0.3114	1.3321	5.1514	43.0905	13.589	-1.601	1.041	17.826	14.549	1.225	1.177	4.149	
1.2	-0.1031	1.3064	4.7828	42.1143	13.696	-1.611	1.042	17.911	14.656	1.222	1.173	4.104	
1.4	0.1052	1.2822	4.4154	41.1548	13.795	-1.607	1.041	17.748	14.566	1.218	1.170	4.060	
1.6	0.3133	1.2585	4.0672	40.2177	13.889	-1.596	1.040	17.433	14.351	1.215	1.168	4.018	
1.8	0.5211	1.2360	3.7297	39.3058	13.972	-1.579	1.038	17.033	14.064	1.211	1.166	3.979	
2.0	0.7294	1.2143	3.4093	38.4202	14.049	-1.560	1.037	16.590	13.739	1.208	1.165	3.942	
T = 4400 K													
-5.0	-6.5398	2.1468	25.5519	85.7042	10.160	-3.374	1.082	154.189	131.605	1.172	1.083	5.171	
-4.8	-6.3217	2.0630	23.1552	82.3407	10.216	-3.544	1.089	157.263	133.450	1.178	1.082	5.069	
-4.6	-6.1036	1.9757	20.7632	79.0149	10.266	-3.579	1.091	151.738	128.490	1.181	1.083	4.966	
-4.4	-5.8857	1.8865	18.4965	75.4954	10.311	-3.476	1.088	138.999	117.902	1.179	1.084	4.866	
-4.2	-5.6687	1.8267	16.4580	72.4931	10.355	-3.262	1.081	121.791	103.809	1.173	1.085	4.776	
-4.0	-5.4534	1.7635	14.7005	70.3754	10.407	-2.984	1.072	103.198	88.544	1.165	1.088	4.697	
-3.8	-5.2401	1.7102	13.2321	68.1074	10.474	-2.689	1.061	85.572	73.925	1.158	1.090	4.632	
-3.6	-5.0298	1.6703	12.0303	66.1284	10.563	-2.408	1.052	70.152	60.967	1.151	1.094	4.580	
-3.4	-4.8194	1.6306	11.0561	64.3985	10.676	-2.158	1.043	57.291	50.009	1.146	1.099	4.540	
-3.2	-4.6117	1.6013	10.2793	62.8747	10.806	-1.944	1.035	46.835	40.995	1.143	1.104	4.511	
-3.0	-4.4053	1.5786	9.6555	61.5189	10.948	-1.766	1.029	38.447	33.662	1.142	1.110	4.491	
-2.8	-4.2032	1.5600	9.1573	60.2991	11.096	-1.619	1.023	31.760	27.765	1.144	1.118	4.480	
-2.6	-3.9990	1.5450	8.7565	59.1855	11.247	-1.499	1.019	26.444	23.037	1.148	1.127	4.475	
-2.4	-3.7926	1.5310	8.4418	58.1590	11.399	-1.402	1.015	22.225	19.258	1.154	1.137	4.478	
-2.2	-3.5898	1.5233	8.1875	57.2010	11.551	-1.324	1.012	18.883	16.246	1.162	1.148	4.486	
-2.0	-3.3876	1.5154	7.9935	56.2975	11.702	-1.262	1.010	16.243	13.853	1.172	1.161	4.498	
-1.8	-3.1857	1.5085	7.8188	55.4564	11.854	-1.214	1.009	14.164	11.961	1.184	1.174	4.515	
-1.6	-2.9841	1.5033	7.6684	54.6036	12.005	-1.176	1.007	12.542	10.477	1.197	1.188	4.534	
-1.4	-2.7827	1.4985	7.5299	53.8057	12.155	-1.148	1.007	11.293	9.330	1.210	1.202	4.553	
-1.2	-2.5814	1.4942	7.4778	53.0217	12.305	-1.130	1.006	10.362	8.468	1.224	1.216	4.573	
-1.0	-2.3802	1.4893	7.3931	52.2699	12.454	-1.119	1.006	9.710	7.856	1.236	1.228	4.589	
-0.8	-2.1789	1.4854	7.3130	51.4847	12.603	-1.117	1.007	9.318	7.477	1.246	1.238	4.599	
-0.6	-1.9774	1.4804	7.2313	50.7199	12.750	-1.125	1.008	9.185	7.328	1.253	1.244	4.602	
-0.4	-1.7757	1.4764	7.1411	49.9693	12.897	-1.143	1.010	9.324	7.417	1.257	1.245	4.595	
-0.2	-1.5739	1.4665	7.0348	49.1657	13.042	-1.174	1.014	9.756	7.760	1.257	1.242	4.578	
0.	-1.3706	1.4574	6.9039	48.3614	13.185	-1.216	1.016	10.491	8.363	1.254	1.235	4.550	
0.2	-1.1670	1.4482	6.7401	47.5291	13.324	-1.275	1.020	11.506	9.203	1.250	1.225	4.514	
0.4	-0.9624	1.4301	6.5366	46.6634	13.461	-1.341	1.025	12.719	10.209	1.246	1.215	4.471	
0.6	-0.7585	1.4119	6.2905	45.7628	13.593	-1.411	1.030	13.984	11.257	1.242	1.206	4.426	
0.8	-0.5503	1.3959	6.0047	44.8316	13.719	-1.474	1.035	15.123	12.203	1.239	1.198	4.378	
1.0	-0.3450	1.3795	5.6970	43.8757	13.840	-1.524	1.038	15.987	12.928	1.237	1.191	4.329	
1.2	-0.1391	1.3650	5.3450	42.9145	13.954	-1.556	1.040	16.508	13.380	1.234	1.186	4.281	
1.4	0.0671	1.3519	5.0027	41.9576	14.060	-1.572	1.041	16.703	13.574	1.230	1.182	4.233	
1.6	0.2613	1.3393	4.6579	41.0116	14.159	-1.574	1.041	16.646	13.568	1.227	1.179	4.188	
1.8	0.4557	1.3264	4.3213	40.0950	14.250	-1.566	1.040	16.423	13.429	1.223	1.176	4.145	
2.0	0.6472	1.3147	3.9971	39.1814	14.332	-1.553	1.039	16.106	13.212	1.219	1.174	4.103	

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5$ N/m²; $\rho_0 = 1.59842$ kg/m³; $R = 8.31469$ J/mole-°K; $A_0 = 2.97904 \times 10^2$ m/sec; and $M_u = 35.828$]

T = 4600 K												
$\log_{10} \frac{p}{p_0}$	$\log_{10} \frac{\rho}{\rho_0}$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_e$	$\frac{T}{P} \left(\frac{\partial p}{\partial T} \right)_P$	$\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p} \right)_T$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	$\frac{A}{A_0}$	
-5.0	-6.5954	2.3390	30.1048	91.5039	10.527	-2.431	1.051	101.085	87.930	1.150	1.094	5.548
-4.8	-6.3839	2.2781	28.3931	88.7287	10.605	-2.790	1.064	121.049	104.377	1.160	1.090	5.465
-4.6	-6.1699	2.2055	26.3682	85.6707	10.677	-3.124	1.076	137.166	117.166	1.171	1.088	5.372
-4.4	-5.9535	2.1242	24.1143	82.4198	10.740	-3.332	1.086	146.505	124.136	1.180	1.086	5.269
-4.2	-5.7356	2.0383	21.7545	79.1014	10.797	-3.520	1.092	147.379	124.255	1.186	1.086	5.160
-4.0	-5.5171	1.9530	19.4315	75.8594	10.847	-3.512	1.093	139.870	117.821	1.187	1.087	5.052
-3.8	-5.2989	1.8732	17.2738	72.8210	10.894	-3.366	1.088	125.906	106.393	1.183	1.088	4.951
-3.6	-5.0822	1.8022	15.3703	70.0718	10.944	-3.122	1.079	108.551	92.281	1.176	1.090	4.860
-3.4	-4.8673	1.7415	13.7570	67.6429	11.004	-2.830	1.069	90.756	77.713	1.168	1.092	4.784
-3.2	-4.6545	1.6912	12.4286	65.5245	11.083	-2.535	1.058	74.508	64.240	1.160	1.096	4.722
-3.0	-4.4439	1.6501	11.3540	63.6808	11.185	-2.265	1.048	60.677	52.604	1.153	1.100	4.673
-2.8	-4.2351	1.6171	10.4933	62.0632	11.207	-2.031	1.040	49.372	42.957	1.149	1.105	4.637
-2.6	-4.0279	1.5906	9.8068	60.6433	11.443	-1.835	1.032	40.318	35.132	1.148	1.112	4.612
-2.4	-3.8221	1.5693	9.2604	59.3695	11.588	-1.673	1.026	33.139	28.858	1.148	1.119	4.596
-2.2	-3.6173	1.5523	8.8255	58.2160	11.737	-1.542	1.021	27.471	23.856	1.152	1.127	4.588
-2.0	-3.4135	1.5386	8.4788	57.1577	11.888	-1.436	1.017	22.999	19.879	1.157	1.137	4.588
-1.8	-3.2103	1.5275	8.2018	56.1747	12.040	-1.352	1.014	19.476	16.724	1.165	1.148	4.593
-1.6	-3.0078	1.5185	7.9795	55.2511	12.192	-1.285	1.012	16.706	14.228	1.174	1.161	4.604
-1.4	-2.8056	1.5110	7.7999	54.3741	12.343	-1.233	1.010	14.537	12.263	1.185	1.174	4.619
-1.2	-2.6038	1.5047	7.6530	53.5328	12.494	-1.193	1.009	12.852	10.729	1.198	1.188	4.636
-1.0	-2.4022	1.4951	7.5305	52.7187	12.644	-1.164	1.008	11.565	9.551	1.211	1.202	4.655
-0.8	-2.2007	1.4939	7.4251	51.9241	12.794	-1.144	1.007	10.617	8.674	1.224	1.215	4.672
-0.6	-1.9992	1.4888	7.3301	51.1423	12.942	-1.135	1.008	9.967	8.065	1.236	1.226	4.687
-0.4	-1.7976	1.4833	7.2397	50.3664	13.090	-1.134	1.008	9.596	7.703	1.246	1.235	4.695
-0.2	-1.5958	1.4771	7.1442	49.5902	13.237	-1.145	1.010	9.504	7.586	1.253	1.241	4.695
0.0	-1.3936	1.4657	7.0389	48.8064	13.382	-1.168	1.012	9.696	7.717	1.257	1.241	4.685
0.2	-1.1908	1.4604	6.9147	48.0075	13.525	-1.203	1.015	10.181	8.099	1.257	1.238	4.664
0.4	-0.9874	1.4489	6.7633	47.1861	13.666	-1.251	1.019	10.943	8.717	1.255	1.232	4.633
0.6	-0.7831	1.4345	6.5776	46.3364	13.802	-1.310	1.024	11.942	9.519	1.252	1.223	4.594
0.8	-0.5778	1.4172	6.3537	45.4557	13.935	-1.373	1.029	13.003	10.407	1.250	1.214	4.550
1.0	-0.3715	1.3969	6.0921	44.5460	14.061	-1.434	1.033	14.031	11.253	1.247	1.207	4.503
1.2	-0.1645	1.3744	5.7989	43.6145	14.182	-1.483	1.037	14.854	11.942	1.244	1.200	4.454
1.4	0.0432	1.3503	5.4839	42.6721	14.295	-1.518	1.039	15.401	12.406	1.241	1.194	4.404
1.6	0.2512	1.3257	5.1582	41.7303	14.401	-1.537	1.040	15.649	12.640	1.238	1.190	4.356
1.8	0.4593	1.3011	4.8315	40.7988	14.498	-1.542	1.040	15.657	12.684	1.234	1.186	4.309
2.0	0.6674	1.2773	4.5109	39.8646	14.586	-1.537	1.040	15.499	12.597	1.230	1.183	4.264

T = 4800 K												
-5.0	-6.6324	2.4412	31.5083	94.6350	10.818	-1.653	1.024	50.414	43.898	1.148	1.122	5.863
-4.8	-6.4268	2.4057	31.0507	92.6601	10.910	-1.895	1.033	65.455	57.078	1.147	1.110	5.795
-4.6	-6.2191	2.3674	29.9037	90.4126	11.009	-2.201	1.044	83.755	72.774	1.151	1.102	5.722
-4.4	-6.0089	2.3126	28.4241	87.8949	11.081	-2.551	1.058	103.359	89.132	1.160	1.096	5.641
-4.2	-5.7960	2.2449	26.6091	84.9897	11.157	-2.905	1.071	121.254	103.570	1.171	1.093	5.549
-4.0	-5.5805	2.1663	24.5127	81.8774	11.226	-3.212	1.083	134.123	113.496	1.182	1.091	5.446
-3.8	-5.3630	2.0803	22.2402	78.6268	11.288	-3.417	1.092	139.400	117.147	1.190	1.090	5.335
-3.6	-5.1442	1.9924	19.9314	75.3802	11.343	-3.482	1.095	136.118	114.056	1.193	1.090	5.221
-3.4	-4.9254	1.9079	17.7306	72.2817	11.395	-3.397	1.092	125.361	105.205	1.192	1.091	5.111
-3.2	-4.7076	1.8313	15.7495	69.4401	11.446	-3.190	1.085	109.816	92.643	1.185	1.092	5.011
-3.0	-4.4916	1.7650	14.0491	66.9121	11.504	-2.911	1.075	92.628	78.711	1.177	1.095	4.925
-2.8	-4.2777	1.7036	12.6393	64.7033	11.578	-2.613	1.064	76.253	65.280	1.168	1.098	4.855
-2.6	-4.0661	1.6644	11.4987	62.7855	11.674	-2.331	1.053	62.010	53.421	1.161	1.102	4.799
-2.4	-3.8565	1.6281	10.5862	61.1153	11.790	-2.083	1.043	50.272	43.499	1.156	1.108	4.758
-2.2	-3.6487	1.5950	9.8613	59.6476	11.922	-1.875	1.035	40.881	35.450	1.153	1.114	4.728
-2.0	-3.4423	1.5757	9.2862	58.3415	12.065	-1.704	1.029	33.469	29.019	1.153	1.121	4.709
-1.8	-3.2372	1.5571	8.8299	57.1642	12.213	-1.566	1.023	27.653	23.921	1.156	1.130	4.699
-1.6	-3.0330	1.5422	8.4671	56.0879	12.363	-1.455	1.019	23.097	19.891	1.161	1.140	4.697
-1.4	-2.8296	1.5301	8.1776	55.0912	12.514	-1.367	1.015	19.530	16.713	1.169	1.151	4.701
-1.2	-2.6267	1.5202	7.9452	54.1554	12.665	-1.298	1.013	16.742	14.214	1.178	1.163	4.711
-1.0	-2.4244	1.5119	7.7569	53.2700	12.816	-1.244	1.011	14.573	12.257	1.189	1.176	4.724
-0.8	-2.2223	1.5048	7.6021	52.4207	12.967	-1.204	1.010	12.902	10.742	1.201	1.190	4.740
-0.6	-2.0205	1.4984	7.4717	51.5986	13.117	-1.175	1.009	11.642	9.591	1.214	1.203	4.757
-0.4	-1.8187	1.4924	7.3579	50.7963	13.266	-1.158	1.009	10.733	8.751	1.227	1.216	4.773
-0.2	-1.6165	1.4862	7.2530	50.0054	13.414	-1.150	1.009	10.137	8.188	1.238	1.227	4.784
0.0	-1.4150	1.4796	7.1498	49.2192	13.561	-1.154	1.010	9.836	7.885	1.247	1.235	4.788
0.2	-1.2127	1.4719	7.0405	48.4303	13.706	-1.170	1.012	9.825	7.835	1.254	1.239	4.784
0.4	-1.0100	1.4626	6.9170	47.6311	13.849	-1.198	1.015	10.103	8.035	1.257	1.239	4.768
0.6	-0.8066	1.4512	6.7712	46.8143	13.990	-1.239	1.019	10.655	8.468	1.258	1.235	4.743
0.8	-0.6024	1.4372	6.5959	45.9737	14.126	-1.290	1.023	11.431	9.092	1.257	1.229	4.708
1.0	-0.3972	1.4203	6.3862	45.1060	14.258	-1.348	1.028	12.334	9.825	1.255	1.221	4.666
1.2	-0.1912	1.4006	6.1420	44.2122	14.385	-1.404	1.033	13.229	10.556	1.253	1.214	4.619
1.4	0.0157	1.3785	5.8677	43.2578	14.504	-1.452	1.036	13.980	11.175	1.251	1.207	4.570
1.6	0.2233	1.3549	5.5717	42.3723	14.616	-1.486	1.039	14.494	11.612	1.248	1.202	4.521
1.8	0.4311	1.3305	5.2642	41.4465	14.720	-1.506	1.040	14.751	11.849	1.245	1.197	4.471
2.0	0.6392	1.3062	4.9544	40.5297	14.814	-1.513	1.040	14.789	11.915	1.241	1.193	4.423

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole}^\circ\text{K}$; $A_0 = 2.97904 \times 10^3 \text{ m/sec}$; and $M_u = 35.828$]

T = 5000 K												
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{g}{R}$	$\log_{10} N_e$	$\frac{T(\theta p)}{p(\theta T)p}$	$\frac{p(\theta p)}{p(\theta T)p}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$
-5.0	-6.4583	2.4875	32.1343	96.1710	11.065	-1.328	1.012	28.829	24.494	1.177	1.163	6.150
-4.8	-6.4556	2.4717	31.7124	94.6071	11.164	-1.420	1.016	34.423	29.519	1.166	1.148	6.091
-4.6	-6.2519	2.4508	31.1603	92.9215	11.261	-1.566	1.021	43.360	37.478	1.157	1.133	6.024
-4.4	-6.0462	2.4224	30.4140	91.0527	11.355	-1.777	1.030	56.057	48.632	1.153	1.119	5.954
-4.2	-5.8398	2.3857	29.4071	88.9387	11.445	-2.055	1.041	72.278	62.604	1.155	1.110	5.881
-4.0	-5.6304	2.3329	28.0848	86.5300	11.530	-2.388	1.054	90.678	78.048	1.162	1.103	5.799
-3.8	-5.4183	2.2684	26.4253	83.8103	11.609	-2.744	1.068	108.688	92.690	1.173	1.098	5.707
-3.6	-5.2034	2.1918	24.4611	80.9196	11.682	-3.073	1.081	123.015	103.876	1.184	1.095	5.603
-3.4	-4.9861	2.1062	22.2809	77.6486	11.748	-3.316	1.091	130.076	109.458	1.194	1.094	5.489
-3.2	-4.7672	2.0167	20.0192	74.4374	11.807	-3.425	1.096	130.062	108.482	1.199	1.094	5.370
-3.0	-4.5480	1.9253	17.8253	71.3352	11.861	-3.381	1.095	121.635	101.501	1.198	1.094	5.254
-2.8	-4.3295	1.8490	15.8243	66.4646	11.915	-3.202	1.089	107.718	90.307	1.193	1.096	5.147
-2.6	-4.1127	1.7790	14.0522	65.8976	11.975	-2.937	1.079	91.426	77.203	1.184	1.098	5.054
-2.4	-3.8982	1.7203	12.6512	63.6513	12.048	-2.640	1.067	75.417	64.182	1.175	1.101	4.977
-2.2	-3.6855	1.6724	11.4840	61.7034	12.142	-2.353	1.056	61.270	52.496	1.167	1.106	4.917
-2.0	-3.4758	1.6335	10.5530	60.0114	12.256	-2.100	1.046	49.542	42.653	1.162	1.117	4.871
-1.8	-3.2676	1.6032	9.8156	58.5289	12.386	-1.886	1.037	40.163	34.664	1.159	1.129	4.839
-1.6	-3.0609	1.5787	9.2330	57.2138	12.527	-1.711	1.030	32.796	28.308	1.159	1.125	4.818
-1.4	-2.8555	1.5552	8.7720	56.0306	12.674	-1.571	1.024	27.050	23.295	1.161	1.134	4.807
-1.2	-2.6511	1.5434	8.4062	54.9505	12.824	-1.459	1.020	22.578	19.358	1.166	1.144	4.804
-1.0	-2.4474	1.5307	8.1142	53.9507	12.975	-1.370	1.016	19.100	16.273	1.174	1.155	4.808
-0.8	-2.2445	1.5201	7.8796	53.0136	13.125	-1.301	1.014	16.402	13.862	1.183	1.167	4.816
-0.6	-2.0419	1.5112	7.6885	52.1247	13.276	-1.249	1.012	14.321	11.991	1.194	1.180	4.829
-0.4	-1.8397	1.5035	7.5300	51.2720	13.426	-1.211	1.011	12.737	10.557	1.206	1.194	4.844
-0.2	-1.6376	1.4963	7.3944	50.4457	13.575	-1.185	1.010	11.566	9.487	1.219	1.207	4.859
0	-1.4355	1.4893	7.2731	49.6369	13.723	-1.170	1.010	10.751	8.732	1.231	1.219	4.871
0.2	-1.2334	1.4819	7.1582	48.8379	13.870	-1.168	1.011	10.258	8.258	1.242	1.228	4.878
0.4	-1.0310	1.4737	7.0414	48.0404	14.015	-1.178	1.013	10.068	8.051	1.251	1.235	4.877
0.6	-0.8281	1.4641	6.9145	47.2370	14.158	-1.200	1.016	10.172	8.096	1.256	1.237	4.867
0.8	-0.6247	1.4525	6.7693	46.4201	14.298	-1.235	1.019	10.548	8.375	1.259	1.236	4.845
1.0	-0.4205	1.4385	6.5986	45.5836	14.435	-1.280	1.023	11.150	8.846	1.260	1.232	4.813
1.2	-0.2154	1.4217	6.3975	44.7239	14.566	-1.332	1.028	11.891	9.438	1.260	1.226	4.774
1.4	-0.0054	1.4022	6.1651	43.8411	14.691	-1.383	1.032	12.651	10.051	1.259	1.219	4.728
1.6	0.1974	1.3804	5.9048	42.9399	14.809	-1.428	1.036	13.303	10.586	1.257	1.213	4.680
1.8	0.4046	1.3571	5.6241	42.0290	14.919	-1.461	1.038	13.760	10.971	1.254	1.208	4.630
2.0	0.6126	1.3325	5.3322	41.1176	15.020	-1.480	1.040	13.995	11.187	1.251	1.203	4.580
T = 5200 K												
-5.0	-6.4802	2.5151	31.8908	97.1934	11.283	-1.262	1.010	24.616	20.650	1.192	1.180	6.354
-4.8	-6.4782	2.5036	31.5859	95.7233	11.386	-1.271	1.010	24.871	20.867	1.192	1.180	6.338
-4.6	-6.2760	2.4910	31.2550	94.2419	11.487	-1.311	1.012	27.045	22.818	1.185	1.171	6.299
-4.4	-6.0753	2.4756	30.8593	92.7028	11.587	-1.390	1.015	31.667	26.956	1.175	1.157	6.241
-4.2	-5.8698	2.4554	30.3484	91.0562	11.684	-1.521	1.021	39.337	33.774	1.165	1.141	6.173
-4.0	-5.6645	2.4283	29.6612	89.2442	11.779	-1.714	1.028	50.538	43.603	1.159	1.127	6.101
-3.8	-5.4592	2.3512	28.7310	87.2036	11.870	-1.974	1.039	65.237	56.265	1.159	1.116	6.024
-3.6	-5.2492	2.2619	27.4956	84.8820	11.957	-2.295	1.052	82.416	70.692	1.166	1.108	5.941
-3.4	-5.0373	2.1789	25.9359	82.2537	12.038	-2.647	1.067	99.830	84.863	1.176	1.103	5.846
-3.2	-4.8226	2.0928	24.0605	79.3458	12.113	-2.981	1.081	114.311	96.196	1.188	1.100	5.739
-3.0	-4.6053	2.1160	21.9538	76.2441	12.181	-3.238	1.092	122.744	102.408	1.199	1.098	5.622
-2.8	-4.3863	2.0263	19.7466	73.0929	12.243	-3.365	1.097	123.245	102.334	1.204	1.097	5.499
-2.6	-4.1668	1.9371	17.5894	70.0132	12.300	-3.338	1.097	115.999	96.325	1.204	1.098	5.377
-2.4	-3.9475	1.8549	15.6129	67.1639	12.357	-3.171	1.091	103.143	86.037	1.199	1.099	5.265
-2.2	-3.7308	1.7830	13.8942	64.6121	12.419	-2.914	1.080	87.699	73.690	1.190	1.101	5.168
-2.0	-3.5158	1.7228	12.4716	62.3789	12.495	-2.620	1.069	72.332	61.266	1.181	1.105	5.087
-1.8	-3.3033	1.6737	11.3162	60.4437	12.590	-2.334	1.057	58.676	50.048	1.172	1.109	5.024
-1.6	-3.0930	1.6344	10.4011	58.7653	12.705	-2.081	1.047	47.350	40.588	1.167	1.115	4.977
-1.4	-2.8846	1.6031	9.6774	57.2964	12.836	-1.868	1.038	38.321	32.928	1.164	1.121	4.944
-1.2	-2.6778	1.5782	9.1072	55.9939	12.977	-1.695	1.031	31.260	26.858	1.164	1.129	4.923
-1.0	-2.4723	1.5583	8.6572	54.8213	13.123	-1.557	1.025	25.786	22.100	1.167	1.139	4.912
-0.8	-2.2678	1.5423	8.3003	53.7511	13.272	-1.448	1.020	21.553	18.385	1.172	1.149	4.909
-0.6	-2.0641	1.5282	8.0152	52.7588	13.423	-1.362	1.017	18.286	15.494	1.180	1.161	4.913
-0.4	-1.8610	1.5133	7.7850	51.8271	13.573	-1.297	1.014	15.772	13.524	1.190	1.173	4.921
-0.2	-1.6583	1.5009	7.5959	50.9409	13.723	-1.248	1.013	13.855	11.533	1.201	1.186	4.933
0	-1.4558	1.5004	7.4337	50.0888	13.872	-1.214	1.012	12.422	10.236	1.214	1.199	4.947
0.2	-1.2535	1.4923	7.2972	49.2602	14.020	-1.193	1.012	11.395	9.295	1.226	1.212	4.959
0.4	-1.0511	1.4841	7.1694	48.4460	14.167	-1.185	1.012	10.724	8.665	1.238	1.222	4.967
0.6	-0.8485	1.4752	7.0417	47.6330	14.312	-1.189	1.014	10.375	8.317	1.248	1.230	4.968
0.8	-0.6454	1.4650	6.9085	46.8276	14.454	-1.207	1.016	10.329	8.230	1.255	1.235	4.960
1.0	-0.4415	1.4530	6.7605	46.0277	14.594	-1.236	1.020	10.557	8.378	1.260	1.236	4.941
1.2	-0.2376	1.4387	6.5903	45.1715	14.729	-1.276	1.024	11.011	8.721	1.263	1.233	4.912
1.4	-0.0324	1.4217	6.3934	44.3160	14.859	-1.323	1.028	11.608	9.187	1.263	1.229	4.875
1.6	0.1736	1.4022	6.1683	43.4406	14.982	-1.370	1.032	12.237	9.688	1.263	1.224	4.830
1.8	0.3804	1.3805	5.9181	42.5494	15.098	-1.410	1.036	12.783	10.132	1.262	1.218	4.782
2.0	0.5877	1.3572	5.6496	41.6506	15.205	-1.440	1.038	13.166	10.454	1.259	1.213	4.732

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^3 \text{ m/sec}$; and $M_u = 35.828$]

T = 5400 K												
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{g}{R}$	$\log_{10} N_0$	$\frac{T}{p} \left(\frac{\partial p}{\partial T} \right)_p$	$\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p} \right)_T$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$
-5.0	-6.7011	2.5418	31.6689	98.1606	11.478	-1.312	1.012	28.012	23.690	1.182	1.169	6.477
-4.8	-6.4989	2.5288	31.3275	96.6518	11.584	-1.277	1.011	25.421	21.340	1.191	1.179	6.488
-4.6	-6.2969	2.5169	31.0173	95.1797	11.688	-1.261	1.010	24.060	20.097	1.197	1.185	6.490
-4.4	-6.0948	2.5051	30.7143	93.7204	11.791	-1.268	1.011	24.149	20.163	1.198	1.185	6.475
-4.2	-5.8926	2.4922	30.3886	92.2440	11.893	-1.304	1.012	26.038	21.849	1.192	1.177	6.437
-4.0	-5.6899	2.4767	30.0019	90.7129	11.992	-1.379	1.015	30.226	25.584	1.181	1.164	6.379
-3.8	-5.4863	2.4565	29.5057	89.0809	12.090	-1.505	1.021	37.279	31.830	1.171	1.147	6.309
-3.6	-5.2814	2.4291	28.8398	87.2895	12.185	-1.691	1.029	47.682	40.928	1.165	1.133	6.233
-3.4	-5.0747	2.3917	27.9384	85.2778	12.277	-1.965	1.039	61.452	52.743	1.165	1.121	6.153
-3.2	-4.8656	2.3419	26.7420	82.9909	12.364	-2.260	1.053	77.681	66.320	1.171	1.113	6.066
-3.0	-4.6536	2.2781	25.2185	80.4029	12.446	-2.607	1.067	94.245	79.742	1.182	1.107	5.968
-2.8	-4.4386	2.2010	23.3871	77.5396	12.522	-2.938	1.082	108.060	90.501	1.194	1.104	5.857
-2.6	-4.2211	2.1138	21.3277	74.4864	12.592	-3.191	1.093	116.041	96.351	1.204	1.102	5.735
-2.4	-4.0018	2.0220	19.1721	71.3783	12.655	-3.312	1.099	116.338	96.151	1.210	1.101	5.607
-2.2	-3.7820	1.9319	17.0713	68.3673	12.715	-3.278	1.098	109.202	90.291	1.209	1.102	5.462
-2.0	-3.5630	1.8492	15.1540	65.5798	12.775	-3.108	1.091	96.786	80.418	1.204	1.103	5.367
-1.8	-3.3458	1.7773	13.4982	63.0895	12.842	-2.849	1.081	82.030	68.677	1.194	1.105	5.267
-1.6	-3.1305	1.7174	12.1272	60.9144	12.922	-2.558	1.068	67.465	56.944	1.185	1.109	5.186
-1.4	-2.9184	1.6687	11.0236	59.0314	13.022	-2.278	1.057	54.606	46.411	1.177	1.114	5.123
-1.2	-2.7081	1.6299	10.1494	57.3981	13.140	-2.031	1.046	44.004	37.576	1.171	1.120	5.076
-1.0	-2.4998	1.5990	9.4620	55.9676	13.272	-1.826	1.037	35.601	30.463	1.169	1.127	5.044
-0.8	-2.2931	1.5745	8.9217	54.6367	13.414	-1.660	1.030	29.069	24.858	1.169	1.135	5.024
-0.6	-2.0877	1.5548	8.4957	53.4004	13.561	-1.529	1.025	24.037	20.491	1.173	1.145	5.014
-0.4	-1.8832	1.5389	8.1574	52.4998	13.710	-1.426	1.020	20.171	17.104	1.179	1.156	5.011
-0.2	-1.6795	1.5257	7.8862	51.5231	13.860	-1.347	1.017	17.210	14.488	1.188	1.168	5.016
0.	-1.4763	1.5145	7.6653	50.6022	14.009	-1.288	1.015	14.955	12.481	1.198	1.180	5.025
0.2	-1.2734	1.5046	7.4812	49.7229	14.158	-1.245	1.014	13.264	10.963	1.210	1.194	5.036
0.4	-1.0707	1.4953	7.3224	48.8734	14.306	-1.218	1.013	12.035	9.847	1.222	1.206	5.046
0.6	-0.8680	1.4861	7.1787	48.0432	14.452	-1.204	1.014	11.199	9.074	1.234	1.217	5.054
0.8	-0.6652	1.4763	7.0406	47.2229	14.597	-1.204	1.015	10.709	8.602	1.245	1.226	5.057
1.0	-0.4615	1.4654	6.8991	46.4040	14.739	-1.217	1.017	10.534	8.401	1.254	1.232	5.050
1.2	-0.2582	1.4527	6.7457	45.5787	14.877	-1.242	1.020	10.636	8.440	1.260	1.235	5.033
1.4	-0.0537	1.4378	6.5734	44.7407	15.011	-1.278	1.024	10.963	8.672	1.264	1.234	5.006
1.6	0.1516	1.4205	6.3773	43.8864	15.139	-1.319	1.028	11.432	9.028	1.266	1.231	4.970
1.8	0.3577	1.4007	6.1563	43.0158	15.260	-1.361	1.032	11.939	9.425	1.267	1.227	4.926
2.0	0.5645	1.3788	5.9133	42.1326	15.372	-1.397	1.036	12.378	9.779	1.266	1.222	4.878
T = 5600 K												
-5.0	-6.7226	2.5754	31.6575	99.3002	11.652	-1.420	1.016	35.126	30.016	1.170	1.151	6.590
-4.8	-6.5156	2.5577	31.2001	97.6608	11.762	-1.357	1.014	30.653	26.008	1.179	1.162	6.598
-4.6	-6.3170	2.5425	30.8117	96.0979	11.869	-1.308	1.012	27.155	22.860	1.188	1.174	6.611
-4.4	-6.1148	2.5293	30.4742	94.5928	11.975	-1.274	1.011	24.719	20.656	1.197	1.184	6.622
-4.2	-5.9127	2.5170	30.1663	93.1230	12.080	-1.260	1.010	23.473	19.519	1.203	1.190	6.623
-4.0	-5.7106	2.5045	29.8639	91.6644	12.183	-1.269	1.011	23.637	19.651	1.203	1.190	6.606
-3.8	-5.5082	2.4914	29.5367	90.1865	12.284	-1.306	1.013	25.554	21.355	1.197	1.182	6.566
-3.6	-5.3054	2.4752	29.1467	88.6529	12.384	-1.384	1.016	29.707	25.041	1.186	1.167	6.505
-3.4	-5.1016	2.4539	28.6440	87.0150	12.481	-1.512	1.022	36.643	31.153	1.176	1.151	6.432
-3.2	-4.8965	2.4251	27.9689	85.2150	12.576	-1.702	1.030	46.801	39.984	1.171	1.136	6.353
-3.0	-4.6894	2.3858	27.0557	83.1947	12.668	-1.959	1.041	60.143	51.353	1.171	1.125	6.269
-2.8	-4.4758	2.3336	25.8477	80.8997	12.756	-2.274	1.055	75.687	64.251	1.178	1.116	6.177
-2.6	-4.2673	2.2671	24.3169	78.3088	12.838	-2.617	1.070	91.260	76.751	1.189	1.111	6.073
-2.4	-4.0517	2.1873	22.4900	75.4556	12.914	-2.937	1.085	103.784	86.397	1.201	1.107	5.955
-2.2	-3.8336	2.0979	20.4554	72.4341	12.983	-3.169	1.096	110.327	91.100	1.211	1.105	5.828
-2.0	-3.6135	2.0045	18.3508	69.3848	13.048	-3.263	1.100	109.372	89.972	1.216	1.105	5.696
-1.8	-3.3935	1.9149	16.3248	66.4564	13.110	-3.203	1.098	101.523	83.636	1.214	1.105	5.567
-1.6	-3.1750	1.8333	14.4982	63.7673	13.174	-3.014	1.090	89.103	73.827	1.207	1.107	5.451
-1.4	-2.9581	1.7630	12.9374	61.3789	13.246	-2.749	1.079	74.948	62.599	1.197	1.110	5.352
-1.2	-2.7435	1.7050	11.6557	59.2990	13.334	-2.461	1.066	61.325	51.639	1.188	1.114	5.273
-1.0	-2.5314	1.6582	10.6310	57.5003	13.439	-2.191	1.055	49.505	41.960	1.180	1.119	5.212
-0.8	-2.3215	1.6209	9.8232	55.9380	13.562	-1.957	1.044	39.877	33.935	1.175	1.125	5.168
-0.6	-2.1135	1.5913	9.1898	54.5652	13.698	-1.764	1.036	32.310	27.530	1.174	1.133	5.138
-0.4	-1.9071	1.5678	8.6924	53.3406	13.841	-1.610	1.029	26.469	22.520	1.175	1.142	5.121
-0.2	-1.7018	1.5488	8.2998	52.2305	13.988	-1.490	1.024	21.998	18.642	1.180	1.152	5.112
0.	-1.4974	1.5332	7.9869	51.2081	14.137	-1.397	1.020	18.589	15.656	1.187	1.164	5.112
0.2	-1.2937	1.5201	7.7339	50.2520	14.286	-1.327	1.017	16.002	13.371	1.197	1.176	5.117
0.4	-1.0904	1.5086	7.5248	49.3456	14.434	-1.276	1.016	14.062	11.643	1.208	1.189	5.125
0.6	-0.8873	1.4980	7.3462	48.4747	14.582	-1.242	1.015	12.643	10.365	1.220	1.202	5.135
0.8	-0.6843	1.4877	7.1869	47.6280	14.728	-1.224	1.015	11.657	9.462	1.232	1.213	5.142
1.0	-0.4811	1.4769	7.0365	46.7950	14.871	-1.220	1.016	11.044	8.882	1.243	1.223	5.143
1.2	-0.2777	1.4651	6.8855	45.9664	15.012	-1.229	1.019	10.758	8.585	1.253	1.230	5.137
1.4	-0.0736	1.4516	6.7252	45.1345	15.149	-1.251	1.022	10.754	8.531	1.261	1.234	5.121
1.6	0.1311	1.4360	6.5486	44.2929	15.281	-1.282	1.025	10.971	8.668	1.266	1.234	5.095
1.8	0.3365	1.4181	6.3512	43.4382	15.407	-1.319	1.029	11.326	8.928	1.269	1.233	5.059
2.0	0.5422	1.3978	6.1321	42.5706	15.524	-1.357	1.033	11.720	9.229	1.270	1.229	5.016

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^3 \text{ m/sec}$; and $M_u = 35.828$]

T = 5800 K													
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_e$	$\frac{T(\frac{\partial p}{\partial T})_p}{\rho(\frac{\partial T}{\partial T})_p}$	$\frac{p(\frac{\partial p}{\partial p})_T}{\rho(\frac{\partial p}{\partial p})_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$	
-5.0	-6.7453	2.6198	31.9293	100.6866	11.804	-1.558	1.022	44.143	37.923	1.164	1.139	6.726	
-4.8	-6.5412	2.5950	31.3091	98.8657	11.919	-1.477	1.019	38.372	32.819	1.169	1.147	6.720	
-4.6	-6.3377	2.5742	30.7861	97.1527	12.031	-1.405	1.016	33.356	28.357	1.176	1.158	6.723	
-4.4	-6.1347	2.5565	30.3449	95.5300	12.141	-1.345	1.014	29.211	24.652	1.185	1.169	6.732	
-4.2	-5.9321	2.5413	29.9602	93.9808	12.249	-1.299	1.012	26.021	21.785	1.194	1.180	6.745	
-4.0	-5.7298	2.5280	29.6399	92.4842	12.354	-1.269	1.011	23.809	19.842	1.203	1.190	6.754	
-3.8	-5.5276	2.5155	29.3359	91.0190	12.458	-1.259	1.011	22.895	18.952	1.208	1.195	6.753	
-3.6	-5.3255	2.5028	29.0323	89.5599	12.561	-1.272	1.011	23.331	19.326	1.207	1.194	6.731	
-3.4	-5.1230	2.4885	28.6573	88.0754	12.662	-1.317	1.014	25.535	21.277	1.200	1.184	6.685	
-3.2	-4.9195	2.4709	28.2912	86.5274	12.762	-1.403	1.018	29.983	25.204	1.190	1.169	6.619	
-3.0	-4.7158	2.4477	27.7623	84.8655	12.859	-1.541	1.024	37.202	31.522	1.180	1.153	6.542	
-2.8	-4.5102	2.4161	27.0457	83.0326	12.954	-1.743	1.033	47.545	40.438	1.176	1.138	6.458	
-2.6	-4.3024	2.3733	26.0886	80.9682	13.045	-2.011	1.045	60.813	51.629	1.178	1.127	6.369	
-2.4	-4.0919	2.3167	24.8276	78.6269	13.132	-2.332	1.060	75.798	63.912	1.186	1.119	6.271	
-2.2	-3.8794	2.2457	23.2506	75.9986	13.213	-2.665	1.075	90.128	75.249	1.198	1.114	6.159	
-2.0	-3.6619	2.1618	21.4000	73.1326	13.289	-2.966	1.089	100.724	83.264	1.210	1.111	6.034	
-1.8	-3.4430	2.0658	19.3800	70.1380	13.358	-3.159	1.099	104.990	86.182	1.218	1.109	5.900	
-1.6	-3.2229	1.9763	17.3343	67.1606	13.424	-3.207	1.101	102.017	83.564	1.221	1.109	5.764	
-1.4	-3.0029	1.8876	15.4070	64.3441	13.489	-3.105	1.097	92.984	76.395	1.217	1.109	5.636	
-1.2	-2.7844	1.8086	13.7010	61.7876	13.558	-2.890	1.088	80.404	66.513	1.209	1.111	5.521	
-1.0	-2.5680	1.7417	12.2654	58.5349	13.637	-2.617	1.076	66.920	55.826	1.199	1.114	5.426	
-0.8	-2.3542	1.6870	11.1005	57.5811	13.733	-2.337	1.063	54.426	45.760	1.189	1.119	5.351	
-0.6	-2.1427	1.6432	10.1759	55.8900	13.847	-2.081	1.051	43.842	37.074	1.183	1.125	5.294	
-0.4	-1.9334	1.6085	9.4504	54.4161	13.976	-1.865	1.042	35.357	29.988	1.179	1.132	5.255	
-0.2	-1.7255	1.5803	8.8823	53.1139	14.114	-1.690	1.034	28.758	23.393	1.175	1.140	5.229	
0.	-1.5198	1.5587	8.4359	51.9449	14.259	-1.552	1.028	23.705	20.053	1.182	1.150	5.215	
0.2	-1.3147	1.5406	8.0820	50.8773	14.406	-1.445	1.023	19.864	16.718	1.188	1.161	5.209	
0.4	-1.1104	1.5255	7.7974	49.8869	14.554	-1.365	1.020	16.961	14.174	1.197	1.173	5.210	
0.6	-0.9067	1.5124	7.5678	48.9536	14.702	-1.307	1.018	14.789	12.252	1.207	1.186	5.216	
0.8	-0.7032	1.5004	7.3659	48.0621	14.849	-1.267	1.017	13.197	10.828	1.219	1.199	5.223	
1.0	-0.4995	1.4869	7.1911	47.1990	14.994	-1.244	1.017	12.078	9.813	1.231	1.210	5.228	
1.2	-0.2964	1.4770	7.0281	46.3532	15.137	-1.236	1.018	11.353	9.141	1.243	1.221	5.229	
1.4	-0.0926	1.4641	6.8669	45.5146	15.276	-1.243	1.020	10.900	8.764	1.253	1.228	5.222	
1.6	0.1117	1.4467	6.6997	44.6754	15.411	-1.261	1.023	10.886	8.632	1.261	1.233	5.206	
1.8	0.3167	1.4332	6.5165	43.8293	15.540	-1.289	1.027	11.009	8.688	1.267	1.234	5.180	
2.0	0.5224	1.4145	6.3163	42.9733	15.663	-1.322	1.030	11.262	8.862	1.271	1.233	5.144	
T = 6000 K													
-5.0	-6.7693	2.6762	32.4934	102.3419	11.934	-1.698	1.028	53.467	45.968	1.163	1.131	6.891	
-4.8	-6.5639	2.6433	31.6907	100.3144	12.057	-1.613	1.025	47.203	40.494	1.166	1.137	6.867	
-4.6	-6.3592	2.6150	31.0003	98.4135	12.175	-1.529	1.022	41.241	35.256	1.170	1.145	6.854	
-4.4	-6.1562	2.5910	30.4119	96.6515	12.285	-1.451	1.019	35.868	30.510	1.176	1.154	6.850	
-4.2	-5.9518	2.5706	29.9193	94.9654	12.401	-1.383	1.016	31.265	26.423	1.183	1.165	6.854	
-4.0	-5.7449	2.5533	29.5017	93.3482	12.510	-1.328	1.014	27.531	23.089	1.192	1.176	6.865	
-3.8	-5.5453	2.5384	29.1432	91.8173	12.617	-1.287	1.012	24.737	20.582	1.202	1.188	6.878	
-3.6	-5.3440	2.5251	28.8248	90.3332	12.722	-1.263	1.011	22.981	18.998	1.210	1.196	6.885	
-3.4	-5.1418	2.5123	28.5245	88.8729	12.826	-1.259	1.011	22.418	18.478	1.213	1.200	6.877	
-3.2	-4.9375	2.4998	28.2156	87.4101	12.928	-1.282	1.012	23.310	19.254	1.211	1.196	6.847	
-3.0	-4.7308	2.4833	27.8642	85.9114	13.029	-1.338	1.015	26.034	21.655	1.202	1.184	6.793	
-2.8	-4.5233	2.4635	27.4273	84.3354	13.128	-1.439	1.020	31.077	26.078	1.192	1.168	6.721	
-2.6	-4.3207	2.4373	26.8502	82.6294	13.225	-1.595	1.027	38.918	32.881	1.184	1.152	6.638	
-2.4	-4.1222	2.4013	26.0705	80.7352	13.319	-1.817	1.038	49.759	42.122	1.181	1.138	6.550	
-2.2	-3.9134	2.3533	25.0264	78.5957	13.409	-2.101	1.051	63.119	53.234	1.186	1.128	6.454	
-2.0	-3.7017	2.2905	23.6764	76.1756	13.494	-2.428	1.067	77.426	64.766	1.195	1.121	6.347	
-1.8	-3.4868	2.2134	22.0256	73.4873	13.574	-2.752	1.082	90.027	74.538	1.208	1.116	6.226	
-1.6	-3.2691	2.1249	20.1389	70.5011	13.649	-3.010	1.095	97.967	80.379	1.219	1.114	6.093	
-1.4	-3.0454	2.0307	18.1401	67.6455	13.719	-3.145	1.101	99.258	81.019	1.225	1.112	5.953	
-1.2	-2.8230	1.9376	16.1761	64.7678	13.786	-3.129	1.101	93.860	76.627	1.225	1.112	5.815	
-1.0	-2.6004	1.8519	14.3765	62.0962	13.854	-2.978	1.094	83.577	68.571	1.219	1.114	5.688	
-0.8	-2.3915	1.7774	12.8206	59.7052	13.930	-2.737	1.083	70.999	58.714	1.209	1.116	5.579	
-0.6	-2.1751	1.7153	11.5366	57.6155	14.019	-2.461	1.071	58.417	48.720	1.199	1.120	5.490	
-0.4	-1.9632	1.6652	10.5041	55.8070	14.125	-2.193	1.058	47.251	39.687	1.191	1.125	5.421	
-0.2	-1.7527	1.6252	9.6922	54.2379	14.247	-1.958	1.047	38.050	32.103	1.185	1.132	5.372	
0.	-1.5441	1.5935	9.0570	52.6618	14.381	-1.764	1.038	30.799	26.025	1.183	1.140	5.338	
0.2	-1.3371	1.5692	8.5593	51.6363	14.522	-1.610	1.031	25.224	21.283	1.185	1.149	5.317	
0.4	-1.1314	1.5476	8.1666	50.9253	14.668	-1.491	1.026	20.991	17.630	1.190	1.160	5.307	
0.6	-0.9266	1.5305	7.8523	49.5033	14.815	-1.401	1.022	17.802	14.863	1.198	1.171	5.304	
0.8	-0.7224	1.5157	7.5954	48.5451	14.962	-1.335	1.020	15.422	12.772	1.208	1.184	5.306	
1.0	-0.5185	1.5023	7.3791	47.6340	15.107	-1.251	1.019	13.679	11.223	1.219	1.196	5.310	
1.2	-0.3148	1.4855	7.1894	46.7554	15.252	-1.264	1.019	12.444	10.113	1.231	1.208	5.314	
1.4	-0.1110	1.4764	7.0139	45.8953	15.393	-1.253	1.020	11.640	9.367	1.243	1.219	5.313	
1.6	0.0932	1.4624	6.8423	45.0495	15.531	-1.257	1.022	11.180	8.924	1.253	1.227	5.305	
1.8	0.2576	1.4465	6.6656	44.2020	15.663	-1.273	1.025	11.016	8.728	1.262	1.232	5.288	
2.0	0.5031	1.4294	6.4771	43.3511	15.789	-1.298	1.028	11.056	8.715	1.269	1.234	5.261	

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 6200 K												
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{g}{R}$	$\log_{10} N_e$	$\frac{T}{\rho} \left(\frac{\partial \rho}{\partial T} \right)_p$	$\frac{p}{\rho} \left(\frac{\partial p}{\partial p} \right)_T$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$
-5.0	-6.7943	2.7433	33.3045	104.2308	12.042	-1.810	1.034	61.519	52.826	1.165	1.127	7.079
-4.8	-6.5878	2.7027	32.3314	102.0039	12.173	-1.740	1.031	55.750	47.812	1.166	1.131	7.040
-4.6	-6.3819	2.6665	31.4661	99.9024	12.299	-1.659	1.028	49.645	42.502	1.168	1.137	7.010
-4.4	-6.1767	2.6348	30.7131	97.9288	12.419	-1.575	1.024	43.634	37.254	1.171	1.144	6.989
-4.2	-5.9722	2.6076	30.0692	96.0780	12.536	-1.494	1.021	38.056	32.358	1.176	1.152	6.979
-4.0	-5.7684	2.5846	29.5243	94.3377	12.650	-1.420	1.018	33.138	28.018	1.183	1.162	6.978
-3.8	-5.5651	2.5651	29.0649	92.6927	12.760	-1.357	1.015	29.012	24.356	1.191	1.173	6.985
-3.6	-5.3623	2.5485	28.6748	91.1253	12.869	-1.308	1.013	25.755	21.450	1.201	1.185	6.997
-3.4	-5.1598	2.5339	28.3360	89.6162	12.975	-1.274	1.012	23.443	19.378	1.210	1.196	7.008
-3.2	-4.9575	2.5205	28.0295	88.1448	13.080	-1.258	1.011	22.187	18.242	1.216	1.203	7.010
-3.0	-4.7552	2.5073	27.7286	86.6872	13.183	-1.264	1.012	22.178	18.216	1.218	1.203	6.994
-2.8	-4.5527	2.4928	27.4071	85.2142	13.285	-1.300	1.014	23.709	19.555	1.212	1.196	6.953
-2.6	-4.3496	2.4752	27.0268	83.6899	13.385	-1.373	1.017	27.194	22.608	1.203	1.182	6.888
-2.4	-4.1456	2.4525	26.5388	82.0681	13.483	-1.495	1.023	33.112	27.757	1.193	1.166	6.808
-2.2	-3.9401	2.4217	25.8883	80.2939	13.579	-1.677	1.032	41.854	35.254	1.187	1.150	6.720
-2.0	-3.7325	2.3798	25.0089	78.3085	13.672	-1.925	1.044	53.356	44.914	1.188	1.138	6.626
-1.8	-3.5223	2.3242	23.8475	76.0633	13.760	-2.227	1.059	66.708	55.819	1.195	1.129	6.521
-1.6	-3.3089	2.2537	22.3817	73.5431	13.844	-2.554	1.075	79.864	66.193	1.207	1.122	6.404
-1.4	-3.0924	2.1657	20.6450	70.7873	13.923	-2.848	1.090	89.983	73.834	1.219	1.119	6.273
-1.2	-2.8734	2.0768	18.7315	67.8957	13.996	-3.046	1.100	94.509	76.981	1.228	1.117	6.131
-1.0	-2.6530	1.9816	16.7807	65.0105	14.066	-3.105	1.103	92.409	75.090	1.231	1.116	5.987
-0.8	-2.4327	1.8911	14.9333	62.2717	14.136	-3.017	1.099	84.635	68.973	1.227	1.116	5.851
-0.6	-2.2137	1.8103	13.2939	59.7804	14.210	-2.817	1.090	73.446	60.268	1.219	1.118	5.729
-0.4	-1.9970	1.7418	11.9129	57.5821	14.295	-2.556	1.077	61.279	50.715	1.208	1.121	5.628
-0.2	-1.7828	1.6858	10.7922	55.6727	14.395	-2.286	1.065	49.910	41.636	1.199	1.126	5.548
0.	-1.5711	1.6410	9.9043	54.0192	14.511	-2.039	1.053	40.245	33.767	1.192	1.132	5.488
0.2	-1.3616	1.6053	9.2087	52.5763	14.641	-1.830	1.043	32.496	27.342	1.189	1.140	5.446
0.4	-1.1538	1.5769	8.6646	51.2996	14.779	-1.662	1.035	26.493	22.284	1.189	1.149	5.419
0.6	-0.9474	1.5539	8.2365	50.1509	14.923	-1.532	1.029	21.929	18.385	1.193	1.159	5.404
0.8	-0.7420	1.5348	7.8950	49.0983	15.068	-1.434	1.025	18.497	15.419	1.200	1.170	5.397
1.0	-0.5374	1.5183	7.6170	48.1174	15.214	-1.362	1.022	15.944	13.189	1.209	1.183	5.396
1.2	-0.3331	1.5035	7.3838	47.1884	15.359	-1.312	1.021	14.077	11.540	1.220	1.195	5.397
1.4	-0.1260	1.4893	7.1800	46.2955	15.502	-1.283	1.021	12.757	10.356	1.232	1.207	5.398
1.6	0.0752	1.4750	6.9925	45.4255	15.641	-1.270	1.022	11.880	9.553	1.244	1.217	5.395
1.8	0.2757	1.4558	6.8106	44.5678	15.776	-1.271	1.024	11.364	9.059	1.254	1.226	5.386
2.0	0.4847	1.4431	6.6253	43.7140	15.906	-1.285	1.026	11.132	8.810	1.264	1.231	5.367
T = 6400 K												
-5.0	-6.8198	2.8183	34.2900	106.2887	12.128	-1.885	1.037	68.035	58.379	1.165	1.124	7.280
-4.8	-6.6125	2.7715	33.1804	103.8923	12.269	-1.837	1.036	63.017	53.982	1.167	1.127	7.231
-4.6	-6.4056	2.7279	32.1500	101.6046	12.403	-1.774	1.033	57.472	49.165	1.169	1.132	7.187
-4.4	-6.1993	2.6885	31.2411	99.4396	12.532	-1.697	1.030	51.533	44.017	1.171	1.137	7.152
-4.2	-5.9936	2.6538	30.4350	97.4035	12.655	-1.614	1.026	45.548	38.817	1.173	1.143	7.125
-4.0	-5.7887	2.6239	29.7403	95.4938	12.774	-1.531	1.023	39.866	33.857	1.177	1.151	7.109
-3.8	-5.5844	2.5982	29.1498	93.7011	12.889	-1.453	1.020	34.743	29.361	1.183	1.160	7.103
-3.6	-5.3808	2.5765	28.6515	92.0115	13.001	-1.386	1.017	30.339	25.475	1.191	1.171	7.107
-3.4	-5.1777	2.5581	28.2303	90.4082	13.111	-1.330	1.014	26.747	22.288	1.200	1.183	7.117
-3.2	-4.9750	2.5422	27.8691	88.8727	13.218	-1.288	1.013	24.035	19.870	1.210	1.194	7.129
-3.0	-4.7726	2.5280	27.5494	87.3855	13.324	-1.263	1.012	22.288	18.303	1.218	1.204	7.136
-2.8	-4.5702	2.5144	27.2494	85.9244	13.428	-1.258	1.012	21.648	17.715	1.222	1.208	7.129
-2.6	-4.3678	2.5003	26.9428	84.4629	13.531	-1.278	1.013	22.344	18.312	1.220	1.205	7.100
-2.4	-4.1649	2.4861	26.5968	82.9691	13.632	-1.331	1.016	24.723	20.389	1.213	1.194	7.045
-2.2	-3.9613	2.4636	26.1591	81.4020	13.731	-1.428	1.021	29.222	24.301	1.202	1.178	6.970
-2.0	-3.7565	2.4363	25.6068	79.7113	13.829	-1.579	1.028	36.285	30.376	1.195	1.162	6.882
-1.8	-3.5498	2.3991	24.8468	77.8395	13.923	-1.794	1.039	46.085	38.656	1.192	1.147	6.788
-1.6	-3.3407	2.3491	23.8355	75.7323	14.014	-2.070	1.053	58.163	48.607	1.197	1.136	6.684
-1.4	-3.1285	2.2843	22.5280	73.3573	14.101	-2.385	1.069	71.032	58.873	1.207	1.129	6.569
-1.2	-2.9132	2.2050	20.9338	70.7289	14.182	-2.694	1.085	82.186	67.429	1.219	1.124	6.440
-1.0	-2.6950	2.1144	19.1217	67.9219	14.259	-2.934	1.097	88.891	72.297	1.230	1.121	6.298
-0.8	-2.4748	2.0187	17.2152	65.0636	14.332	-3.050	1.103	89.446	72.423	1.235	1.120	6.150
-0.6	-2.2542	1.9250	15.3574	62.2961	14.403	-3.019	1.102	84.018	68.093	1.234	1.120	6.006
-0.4	-2.0345	1.8394	13.6681	59.7423	14.478	-2.861	1.095	74.397	60.639	1.227	1.121	5.874
-0.2	-1.8167	1.7656	12.2188	57.4635	14.561	-2.623	1.083	62.967	51.748	1.217	1.124	5.762
0.	-1.6014	1.7044	11.0281	55.4745	14.657	-2.358	1.070	51.722	42.866	1.207	1.128	5.671
0.2	-1.3886	1.6551	10.0776	53.7507	14.769	-2.105	1.058	41.846	34.915	1.199	1.133	5.603
0.4	-1.1782	1.6158	9.3307	52.2509	14.895	-1.885	1.047	33.774	28.289	1.194	1.140	5.553
0.6	-0.9697	1.5845	8.7468	50.9304	15.030	-1.707	1.038	27.461	23.016	1.193	1.149	5.520
0.8	-0.7627	1.5552	8.2881	49.7481	15.171	-1.567	1.032	22.646	18.934	1.196	1.159	5.499
1.0	-0.5558	1.5382	7.9231	48.6700	15.315	-1.462	1.027	19.026	15.827	1.202	1.170	5.489
1.2	-0.3517	1.5201	7.6266	47.6694	15.460	-1.385	1.024	16.341	13.494	1.211	1.182	5.484
1.4	-0.1470	1.5038	7.3783	46.7248	15.603	-1.332	1.023	14.382	11.773	1.222	1.195	5.483
1.6	0.0575	1.4883	7.1617	45.8193	15.744	-1.300	1.023	12.998	10.538	1.233	1.206	5.481
1.8	0.2621	1.4727	6.9631	44.9389	15.882	-1.286	1.024	12.071	9.694	1.245	1.217	5.476
2.0	0.4670	1.4562	6.7714	44.0728	16.014	-1.286	1.026	11.510	9.163	1.256	1.225	5.464

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $P_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 6600 K												
$\log_{10} \frac{P}{P_0}$	$\log_{10} \frac{\rho}{\rho_0}$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_e$	$\frac{T(\partial P)}{P(\partial T)_P}$	$\frac{P(\partial P)}{P(\partial P)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$
-5.0	-6.6454	2.8991	35.4208	106.4917	12.197	-1.959	1.040	75.778	65.080	1.164	1.120	7.485
-4.8	-6.6375	2.8470	34.1850	105.9329	12.346	-1.911	1.039	69.766	59.755	1.168	1.124	7.431
-4.6	-6.6299	2.7976	33.0321	103.4803	12.490	-1.862	1.037	64.372	55.022	1.170	1.128	7.380
-4.4	-6.6227	2.7513	31.9685	101.1392	12.627	-1.801	1.035	58.824	50.200	1.172	1.132	7.332
-4.2	-6.6160	2.7092	31.0067	98.9202	12.758	-1.728	1.032	52.974	45.138	1.174	1.137	7.292
-4.0	-5.6099	2.6717	30.1557	96.8305	12.883	-1.646	1.029	47.029	39.991	1.176	1.143	7.261
-3.8	-5.6046	2.6390	29.4173	94.8692	13.004	-1.562	1.025	41.296	35.013	1.179	1.151	7.240
-3.6	-5.3999	2.6110	28.7869	93.0303	13.121	-1.482	1.021	36.044	30.426	1.185	1.160	7.229
-3.4	-5.1960	2.5872	28.2537	91.3003	13.234	-1.411	1.018	31.448	26.392	1.192	1.170	7.228
-3.2	-4.9926	2.5671	27.8038	89.6636	13.345	-1.350	1.016	27.616	23.010	1.200	1.182	7.235
-3.0	-4.7897	2.5499	27.4210	88.1027	13.453	-1.303	1.014	24.615	20.347	1.210	1.193	7.247
-2.8	-4.5871	2.5347	27.0873	86.5983	13.560	-1.271	1.012	22.516	18.474	1.219	1.204	7.257
-2.6	-4.3847	2.5206	26.7824	85.1294	13.665	-1.257	1.012	21.431	17.494	1.225	1.211	7.257
-2.4	-4.1822	2.5065	26.4819	83.6712	13.768	-1.266	1.013	21.540	17.570	1.226	1.211	7.237
-2.2	-3.9795	2.4909	26.1564	82.1950	13.870	-1.305	1.015	23.131	18.949	1.221	1.203	7.191
-2.0	-3.7762	2.4718	25.7675	80.6631	13.970	-1.383	1.019	26.595	21.956	1.211	1.189	7.122
-1.8	-3.5718	2.4469	25.2668	79.0297	14.068	-1.511	1.026	32.374	26.928	1.202	1.172	7.036
-1.6	-3.3657	2.4131	24.5962	77.2397	14.164	-1.699	1.035	40.758	34.033	1.198	1.157	6.941
-1.4	-3.1574	2.3674	23.6950	75.2371	14.257	-1.949	1.048	51.572	42.992	1.200	1.164	6.838
-1.2	-2.9462	2.3072	22.5154	72.9806	14.346	-2.249	1.064	63.756	52.786	1.208	1.135	6.724
-1.0	-2.7318	2.2319	21.0463	70.4657	14.430	-2.560	1.080	75.192	61.648	1.220	1.129	6.595
-0.8	-2.5143	2.1439	19.3352	67.7468	14.509	-2.824	1.094	83.199	67.570	1.231	1.125	6.453
-0.6	-2.2946	2.0485	17.4886	64.9347	14.585	-2.981	1.103	85.089	69.178	1.239	1.124	6.303
-0.4	-2.0738	1.9529	15.6454	62.1702	14.659	-2.996	1.104	82.222	66.336	1.239	1.123	6.152
-0.2	-1.8536	1.8639	13.9350	59.5813	14.734	-2.877	1.098	74.115	60.061	1.234	1.124	6.013
0.	-1.6350	1.7857	12.4429	57.2494	14.816	-2.664	1.087	63.571	51.919	1.224	1.126	5.891
0.2	-1.4187	1.7203	11.2022	55.2019	14.910	-2.408	1.075	52.676	43.394	1.214	1.130	5.791
0.4	-1.2051	1.6671	10.2045	53.4248	15.019	-2.154	1.062	42.809	35.527	1.205	1.135	5.714
0.6	-0.9935	1.6246	9.4180	51.8807	15.142	-1.928	1.051	34.592	28.843	1.199	1.142	5.658
0.8	-0.7847	1.5907	8.8024	50.5249	15.275	-1.742	1.041	28.096	23.460	1.198	1.150	5.619
1.0	-0.5772	1.5632	8.3189	49.3154	15.414	-1.596	1.035	23.119	19.270	1.200	1.160	5.594
1.2	-0.3708	1.5405	7.9347	48.2168	15.556	-1.485	1.030	19.378	16.077	1.205	1.171	5.579
1.4	-0.1652	1.5209	7.6228	47.2001	15.699	-1.405	1.026	16.607	13.683	1.214	1.183	5.571
1.6	0.0358	1.5032	7.3616	46.2425	15.841	-1.350	1.025	14.592	11.920	1.224	1.195	5.567
1.8	0.2448	1.4863	7.1337	45.3263	15.980	-1.316	1.025	13.169	10.656	1.236	1.206	5.562
2.0	0.4498	1.4693	6.9249	44.4370	16.114	-1.301	1.026	12.212	9.789	1.248	1.216	5.554
T = 6800 K												
-5.0	-6.6716	2.9889	36.7923	110.9402	12.257	-2.102	1.045	89.760	77.125	1.164	1.113	7.693
-4.8	-6.6629	2.9293	35.3601	108.1455	12.411	-2.008	1.042	79.351	68.023	1.167	1.119	7.635
-4.6	-6.6456	2.8738	34.0594	105.5088	12.561	-1.943	1.041	71.870	61.445	1.170	1.124	7.579
-4.4	-6.6286	2.8216	32.8558	102.9977	12.705	-1.887	1.039	65.758	56.089	1.172	1.128	7.524
-4.2	-6.6090	2.7728	31.7563	100.5060	12.844	-1.825	1.037	59.962	51.052	1.175	1.133	7.474
-4.0	-5.5930	2.7281	30.7562	98.3395	12.977	-1.753	1.034	54.074	45.965	1.176	1.138	7.430
-3.8	-5.6255	2.6881	29.8672	96.2036	13.105	-1.672	1.030	48.132	40.837	1.179	1.144	7.394
-3.6	-5.4198	2.6530	29.0324	94.1931	13.227	-1.588	1.027	42.369	35.851	1.182	1.151	7.369
-3.4	-5.2149	2.6228	28.4281	92.3203	13.345	-1.507	1.023	37.033	31.213	1.186	1.160	7.354
-3.2	-5.0106	2.5971	27.8653	90.5559	13.460	-1.432	1.020	32.310	27.085	1.193	1.170	7.350
-3.0	-4.8069	2.5753	27.3903	88.8899	13.571	-1.368	1.017	28.311	23.572	1.201	1.181	7.354
-2.8	-4.6036	2.5568	26.9877	87.3056	13.681	-1.316	1.015	25.107	20.743	1.210	1.193	7.365
-2.6	-4.4011	2.5407	26.6403	85.7846	13.788	-1.279	1.013	22.760	18.658	1.220	1.204	7.376
-2.4	-4.1985	2.5260	26.3285	84.3062	13.893	-1.259	1.012	21.357	17.401	1.227	1.212	7.380
-2.2	-3.9961	2.5117	26.0295	82.8472	13.997	-1.260	1.013	21.050	17.109	1.230	1.215	7.366
-2.0	-3.7934	2.4963	25.7157	81.3802	14.100	-1.289	1.014	22.088	17.998	1.227	1.210	7.328
-1.8	-3.5902	2.4780	25.3518	79.8706	14.200	-1.353	1.018	24.806	20.348	1.219	1.198	7.265
-1.6	-3.3861	2.4546	24.8932	78.2761	14.299	-1.463	1.024	29.617	24.484	1.210	1.181	7.181
-1.4	-3.1805	2.4231	24.2845	76.5443	14.396	-1.630	1.033	36.885	30.647	1.204	1.165	7.086
-1.2	-2.9728	2.3804	23.4605	74.6195	14.490	-1.860	1.045	46.585	38.705	1.204	1.152	6.982
-1.0	-2.7623	2.3237	22.3856	72.4548	14.581	-2.143	1.060	57.964	47.896	1.210	1.142	6.868
-0.8	-2.5486	2.2517	21.0200	70.0351	14.667	-2.450	1.077	69.247	56.693	1.221	1.135	6.740
-0.6	-2.3318	2.1660	19.3999	67.3973	14.749	-2.726	1.091	77.905	63.162	1.233	1.130	6.597
-0.4	-2.1124	2.0713	17.6172	64.6387	14.827	-2.910	1.102	81.680	65.763	1.242	1.127	6.444
-0.2	-1.8916	1.9747	15.8045	61.8944	14.902	-2.955	1.105	79.712	64.056	1.244	1.127	6.289
0.	-1.6710	1.8831	14.0938	59.2957	14.979	-2.872	1.100	72.905	58.787	1.240	1.127	6.143
0.2	-1.4518	1.8017	12.5805	56.9349	15.062	-2.682	1.091	63.254	51.376	1.231	1.129	6.013
0.4	-1.2349	1.7329	11.3104	54.8512	15.155	-2.437	1.078	52.839	43.290	1.221	1.132	5.906
0.6	-1.0205	1.6766	10.2815	53.0377	15.262	-2.186	1.065	43.150	35.629	1.211	1.137	5.822
0.8	-0.8077	1.6314	9.4673	51.4621	15.383	-1.958	1.054	34.942	29.006	1.205	1.143	5.759
1.0	-0.5986	1.5952	8.8288	50.0810	15.514	-1.768	1.044	28.388	23.614	1.202	1.151	5.715
1.2	-0.3909	1.5659	8.3272	48.8518	15.651	-1.617	1.037	23.343	19.393	1.204	1.161	5.686
1.4	-0.1840	1.5415	7.9285	47.7377	15.792	-1.503	1.032	19.548	16.171	1.209	1.172	5.672
1.6	0.0219	1.5204	7.6045	46.7087	15.933	-1.421	1.028	16.741	13.757	1.217	1.183	5.656
1.8	0.2274	1.5014	7.3324	45.7413	16.072	-1.365	1.027	14.706	11.982	1.227	1.195	5.649
2.0	0.4377	1.4831	7.0952	44.8166	16.208	-1.330	1.027	13.270	10.713	1.239	1.207	5.641

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; p₀ = 1.01325 × 10⁵ N/m²; ρ₀ = 1.59842 kg/m³; R = 8.31469 J/mole-°K;A₀ = 2.97904 × 10² m/sec; and M_u = 35.828]

T = 7000 K												
log ₁₀ p/p ₀	log ₁₀ ρ/ρ ₀	Z	H RT	S R	log ₁₀ N _e	T (p/p ₀) _T	p (p/p ₀) _T	C _p R	C _v R	γ	γ _E	A A ₀
-5.0	-6.8996	3.0965	36.6179	113.8571	12.314	-2.359	1.055	113.270	96.944	1.168	1.107	7.922
-4.8	-6.6951	3.0231	36.8324	110.6628	12.468	-2.185	1.049	95.860	82.099	1.168	1.113	7.847
-4.6	-6.4797	2.9581	35.2891	107.7428	12.621	-2.064	1.045	83.298	71.239	1.169	1.119	7.782
-4.4	-6.2709	2.8987	33.9138	105.0189	12.772	-1.980	1.043	74.250	63.351	1.172	1.124	7.722
-4.2	-6.0625	2.8435	32.6631	102.4461	12.917	-1.913	1.041	67.206	57.204	1.175	1.129	7.665
-4.0	-5.8546	2.7921	31.5204	100.0059	13.057	-1.847	1.038	60.968	51.791	1.177	1.134	7.612
-3.8	-5.6472	2.7450	30.4861	97.6968	13.192	-1.774	1.035	54.917	46.570	1.179	1.139	7.565
-3.6	-5.4405	2.7027	29.5652	95.5219	13.320	-1.694	1.032	48.920	41.408	1.181	1.145	7.526
-3.4	-5.2345	2.6655	28.7602	93.4809	13.444	-1.609	1.028	43.119	36.406	1.184	1.152	7.497
-3.2	-5.0292	2.6333	28.0681	91.5687	13.563	-1.526	1.025	37.727	31.740	1.189	1.160	7.478
-3.0	-4.8247	2.6059	27.4806	89.7752	13.679	-1.450	1.021	32.919	27.555	1.195	1.170	7.471
-2.8	-4.6208	2.5827	26.9847	88.0845	13.791	-1.382	1.018	28.810	23.961	1.202	1.181	7.473
-2.6	-4.4174	2.5629	26.5657	86.4810	13.901	-1.328	1.015	25.470	21.022	1.212	1.193	7.482
-2.4	-4.2145	2.5459	26.2060	84.9449	14.009	-1.287	1.014	22.953	18.796	1.221	1.205	7.493
-2.2	-4.0115	2.5305	25.8871	83.4572	14.115	-1.262	1.013	21.334	17.352	1.229	1.214	7.499
-2.0	-3.8094	2.5158	25.5871	81.9952	14.219	-1.258	1.013	20.737	16.806	1.234	1.218	7.491
-1.8	-3.6067	2.5005	25.2799	80.5329	14.322	-1.279	1.014	21.382	17.347	1.233	1.215	7.459
-1.6	-3.4036	2.4826	24.9310	79.0374	14.423	-1.334	1.017	23.566	19.226	1.226	1.205	7.400
-1.4	-3.1996	2.4601	24.5014	77.4686	14.523	-1.431	1.023	27.680	22.753	1.217	1.189	7.319
-1.2	-2.9943	2.4301	23.9363	75.7772	14.621	-1.583	1.031	34.087	28.182	1.210	1.173	7.224
-1.0	-2.7870	2.3894	23.1775	73.9092	14.716	-1.795	1.043	42.870	35.483	1.208	1.159	7.119
-0.8	-2.5770	2.3351	22.1703	71.8124	14.807	-2.064	1.058	53.472	44.064	1.214	1.147	7.003
-0.6	-2.3639	2.2654	20.8856	69.4680	14.895	-2.363	1.074	64.376	52.594	1.224	1.140	6.875
-0.4	-2.1474	2.1815	19.3424	66.9003	14.979	-2.643	1.090	73.239	59.250	1.236	1.134	6.731
-0.2	-1.9283	2.0875	17.6207	64.1954	15.059	-2.843	1.101	77.762	62.435	1.245	1.131	6.575
0.0	-1.7076	1.9902	15.8455	61.4813	15.136	-2.916	1.105	76.632	61.519	1.249	1.130	6.416
0.2	-1.4868	1.8970	14.1498	58.8308	15.215	-2.853	1.102	71.048	57.039	1.246	1.130	6.265
0.4	-1.2671	1.8142	12.6344	56.5215	15.298	-2.681	1.093	62.200	50.278	1.237	1.132	6.129
0.6	-1.0497	1.7418	11.3515	54.4206	15.392	-2.448	1.081	52.311	42.651	1.226	1.135	6.015
0.8	-0.8348	1.6832	10.3071	52.5881	15.498	-2.202	1.068	42.916	35.274	1.217	1.139	5.924
1.0	-0.6224	1.6358	9.4773	50.9945	15.617	-1.975	1.056	34.846	28.805	1.210	1.145	5.856
1.2	-0.4122	1.5978	8.8253	49.5993	15.746	-1.783	1.046	28.348	23.492	1.207	1.153	5.808
1.4	-0.2037	1.5669	8.3124	48.3569	15.882	-1.631	1.039	23.326	19.312	1.208	1.163	5.775
1.6	0.0035	1.5411	7.9040	47.2329	16.021	-1.516	1.034	19.543	16.116	1.213	1.173	5.753
1.8	0.2096	1.5187	7.5714	46.1958	16.160	-1.433	1.030	16.750	13.723	1.221	1.185	5.739
2.0	0.4157	1.4983	7.2916	45.2214	16.297	-1.377	1.029	14.729	11.968	1.231	1.196	5.728
T = 7200 K												
-5.0	-6.8305	3.2325	41.1207	117.4812	12.370	-2.708	1.070	145.272	123.118	1.180	1.103	8.194
-4.8	-6.7175	3.1373	38.8007	113.6951	12.524	-2.464	1.061	120.851	102.892	1.175	1.107	8.088
-4.6	-6.5961	3.0562	36.8552	110.3280	12.677	-2.268	1.054	101.592	86.665	1.172	1.113	8.002
-4.4	-6.4759	2.9854	35.2010	107.2790	12.830	-2.124	1.049	87.217	74.372	1.173	1.118	7.929
-4.2	-6.3586	2.9217	33.7457	104.4648	12.980	-2.021	1.045	76.700	65.284	1.175	1.124	7.863
-4.0	-6.2478	2.8633	32.4417	101.8278	13.125	-1.941	1.043	68.659	58.309	1.177	1.129	7.803
-3.8	-6.1435	2.8093	31.2601	99.3602	13.266	-1.869	1.040	61.861	52.428	1.180	1.135	7.747
-3.6	-6.0468	2.7599	30.1945	96.9925	13.401	-1.793	1.037	55.543	46.989	1.182	1.140	7.696
-3.4	-5.9568	2.7155	29.2463	94.7836	13.531	-1.711	1.033	49.433	41.743	1.184	1.146	7.654
-3.2	-5.8745	2.6764	28.4170	92.7130	13.656	-1.626	1.030	43.580	36.712	1.187	1.153	7.622
-3.0	-5.7949	2.6425	27.7032	90.7749	13.776	-1.542	1.026	38.145	32.024	1.191	1.161	7.601
-2.8	-5.7182	2.6135	27.0962	88.9576	13.892	-1.463	1.022	33.286	27.812	1.197	1.171	7.591
-2.6	-5.6434	2.5890	26.5840	87.2477	14.005	-1.394	1.019	29.112	24.173	1.204	1.182	7.590
-2.4	-5.5706	2.5682	26.1515	85.6278	14.116	-1.337	1.016	25.687	21.172	1.213	1.194	7.598
-2.2	-5.4997	2.5502	25.7820	84.0799	14.224	-1.293	1.014	23.063	18.859	1.223	1.206	7.609
-2.0	-5.4308	2.5343	25.4568	82.5937	14.330	-1.265	1.013	21.302	17.296	1.232	1.216	7.616
-1.8	-5.3622	2.5192	25.1548	81.1183	14.435	-1.257	1.013	20.512	16.581	1.237	1.221	7.611
-1.6	-5.2945	2.5036	24.8506	79.6576	14.538	-1.274	1.014	20.889	16.885	1.237	1.220	7.583
-1.4	-5.2284	2.4859	24.5126	78.1705	14.640	-1.321	1.017	22.700	18.434	1.231	1.211	7.528
-1.2	-5.1635	2.4658	24.1066	76.6185	14.740	-1.410	1.022	26.311	21.520	1.223	1.196	7.449
-1.0	-5.0974	2.4446	23.5643	74.9542	14.838	-1.551	1.030	32.084	26.400	1.215	1.180	7.354
-0.8	-5.0303	2.4251	22.8465	73.1238	14.934	-1.751	1.041	40.144	33.093	1.213	1.165	7.247
-0.6	-4.9605	2.4022	21.8917	71.0776	15.026	-2.008	1.056	50.063	41.117	1.217	1.153	7.130
-0.4	-4.8877	2.3740	20.6673	68.7897	15.116	-2.299	1.072	60.494	49.286	1.227	1.144	7.000
-0.2	-4.8161	2.3411	19.1849	66.2746	15.201	-2.578	1.088	69.263	55.890	1.239	1.139	6.854
0.0	-4.7426	2.3075	17.5169	63.6229	15.282	-2.785	1.100	74.121	59.336	1.249	1.135	6.696
0.2	-4.6719	2.2759	15.7820	60.5445	15.362	-2.871	1.105	73.819	58.903	1.253	1.134	6.533
0.4	-4.6005	2.2455	14.1113	58.3748	15.442	-2.824	1.103	66.762	54.989	1.250	1.133	6.377
0.6	-4.5281	2.2162	12.6084	56.0146	15.526	-2.666	1.095	60.584	48.765	1.242	1.135	6.236
0.8	-4.4548	2.1871	11.3287	53.9139	15.611	-2.444	1.083	51.214	41.579	1.232	1.137	6.117
1.0	-4.3800	2.1657	10.2826	52.0777	15.727	-2.204	1.070	42.183	34.528	1.222	1.142	6.022
1.2	-4.3032	2.1437	9.4441	50.4791	15.846	-1.980	1.058	34.351	28.285	1.214	1.148	5.950
1.4	-4.2246	2.1264	8.7925	49.0777	15.974	-1.789	1.048	28.006	23.123	1.211	1.156	5.897
1.6	-4.1458	2.1143	8.2748	47.8315	16.108	-1.638	1.041	23.085	19.047	1.212	1.165	5.861
1.8	-4.0668	2.1062	7.8616	46.7033	16.245	-1.524	1.035	19.379	15.926	1.217	1.175	5.836
2.0	-3.9875	2.1016	7.5258	45.6622	16.381	-1.442	1.032	16.645	13.592	1.225	1.186	5.819

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[80% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 7400 K													
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} n_e$	$\frac{T}{p} \left(\frac{\partial p}{\partial T} \right)_p$	$\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p} \right)_T$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$	$\frac{\Delta}{A_0}$
-5.0	-6.9449	3.4046	44.4180	121.9485	12.426	-3.074	1.086	181.025	151.388	1.196	1.101	8.518	
-4.9	-6.7488	3.2607	41.4321	117.4238	12.579	-2.806	1.075	152.228	128.206	1.187	1.104	8.373	
-4.8	-6.5347	3.1762	38.5378	113.4432	12.732	-2.555	1.066	127.029	107.569	1.181	1.108	8.253	
-4.4	-6.3224	3.0875	36.8528	109.9165	12.884	-2.345	1.058	106.521	90.475	1.177	1.113	8.155	
-4.2	-6.1115	3.0107	35.0849	106.7449	13.036	-2.182	1.052	90.749	77.124	1.177	1.119	8.073	
-4.0	-5.9016	2.9426	33.5521	103.8419	13.185	-2.062	1.048	78.980	67.041	1.178	1.124	8.002	
-3.8	-5.6923	2.8809	32.1928	101.1418	13.331	-1.965	1.045	69.998	59.301	1.180	1.130	7.937	
-3.5	-5.4837	2.8242	30.9733	98.6089	13.472	-1.889	1.042	62.605	52.932	1.183	1.136	7.878	
-3.4	-5.2757	2.7726	29.8794	96.2264	13.607	-1.808	1.038	55.962	47.229	1.185	1.141	7.825	
-3.2	-5.0684	2.7263	28.9090	93.9900	13.738	-1.724	1.035	49.699	41.865	1.187	1.147	7.780	
-3.0	-4.8618	2.6855	28.0606	91.8957	13.863	-1.638	1.031	43.777	36.791	1.190	1.154	7.745	
-2.9	-4.6561	2.6501	27.3303	89.9370	13.984	-1.552	1.027	38.308	32.088	1.194	1.163	7.722	
-2.6	-4.4511	2.6159	26.7093	88.1028	14.100	-1.473	1.023	33.422	27.867	1.199	1.172	7.709	
-2.4	-4.2466	2.5842	26.1853	86.3784	14.214	-1.402	1.020	29.219	24.216	1.207	1.183	7.707	
-2.2	-4.0432	2.5575	25.7432	84.7467	14.325	-1.343	1.017	25.754	21.190	1.215	1.195	7.713	
-2.0	-3.8400	2.5338	25.3653	83.1895	14.433	-1.298	1.015	23.073	18.434	1.225	1.207	7.724	
-1.8	-3.6372	2.5132	25.0363	81.6873	14.540	-1.268	1.014	21.230	17.204	1.234	1.218	7.732	
-1.6	-3.4345	2.5217	24.7322	80.2184	14.645	-1.257	1.013	20.343	16.388	1.240	1.224	7.738	
-1.4	-3.2319	2.5059	24.4533	78.7579	14.748	-1.271	1.014	20.528	16.340	1.241	1.224	7.703	
-1.2	-3.0287	2.4880	24.0267	77.2753	14.850	-1.314	1.017	22.093	17.369	1.236	1.216	7.650	
-1.0	-2.8249	2.4660	23.6956	75.7332	14.951	-1.397	1.022	25.360	20.650	1.228	1.202	7.572	
-0.8	-2.6217	2.4470	23.1771	74.0855	15.049	-1.531	1.030	30.678	25.133	1.221	1.185	7.476	
-0.6	-2.4197	2.4370	22.4952	72.2799	15.145	-1.723	1.041	36.191	31.355	1.218	1.170	7.368	
-0.4	-2.2021	2.4355	21.5652	70.2670	15.239	-1.971	1.055	47.529	38.897	1.222	1.158	7.249	
-0.2	-1.9504	2.4779	20.3824	68.0191	15.329	-2.254	1.072	57.470	46.670	1.231	1.149	7.116	
0.	-1.7743	2.4954	18.9458	65.5520	15.415	-2.529	1.088	65.969	53.059	1.243	1.143	6.968	
0.2	-1.5554	2.4919	17.3224	62.9387	15.498	-2.737	1.100	70.832	56.521	1.253	1.139	6.807	
0.4	-1.3347	2.0049	15.6272	60.2582	15.579	-2.899	1.106	70.810	56.311	1.257	1.137	6.640	
0.6	-1.1136	1.9089	13.9366	57.7588	15.661	-2.789	1.104	66.209	52.760	1.255	1.137	6.480	
0.8	-0.8936	1.8227	12.5095	55.4209	15.747	-2.640	1.096	58.546	46.953	1.247	1.138	6.335	
1.0	-0.6755	1.7486	11.2465	53.3361	15.843	-2.426	1.084	49.661	40.170	1.236	1.140	6.212	
1.2	-0.4560	1.6873	10.2114	51.5104	15.950	-2.192	1.071	41.034	33.466	1.226	1.145	6.113	
1.4	-0.2470	1.6374	9.3846	49.9185	16.068	-1.972	1.059	33.514	27.497	1.219	1.151	6.038	
1.6	-0.0361	1.5970	8.7319	48.5213	16.185	-1.787	1.050	27.400	22.543	1.215	1.158	5.982	
1.8	0.1730	1.5676	8.2158	47.2776	16.328	-1.638	1.042	22.652	18.624	1.216	1.167	5.943	
2.0	0.3608	1.5358	7.8021	46.1504	16.463	-1.527	1.037	19.075	15.622	1.221	1.177	5.915	
T = 7600 K													
-5.0	-7.0223	3.6129	46.4507	127.2178	12.478	-3.350	1.099	212.908	175.824	1.211	1.101	8.893	
-4.8	-6.7733	3.4581	44.7842	121.9240	12.633	-3.137	1.090	185.042	153.831	1.203	1.103	8.707	
-4.6	-6.5622	3.3250	41.6454	117.2240	12.786	-2.881	1.080	156.989	131.437	1.194	1.106	8.548	
-4.4	-6.3512	3.2120	39.0263	113.0805	12.938	-2.630	1.070	131.615	110.854	1.187	1.109	8.415	
-4.2	-6.1380	3.1161	36.7958	109.4131	13.089	-2.410	1.062	110.374	93.323	1.183	1.114	8.306	
-4.0	-5.9264	3.0376	34.8254	106.1312	13.240	-2.234	1.055	93.633	79.281	1.181	1.119	8.215	
-3.8	-5.7155	2.9611	33.3233	103.1454	13.388	-2.100	1.050	80.882	68.448	1.182	1.125	8.137	
-3.6	-5.5027	2.8899	31.9126	100.3862	13.533	-1.996	1.047	71.092	60.069	1.184	1.131	8.068	
-3.4	-5.2972	2.8367	30.6581	97.9119	13.674	-1.907	1.043	63.137	53.249	1.186	1.137	8.005	
-3.2	-5.0906	2.7930	29.5401	95.4002	13.810	-1.821	1.040	56.161	47.280	1.188	1.142	7.949	
-3.0	-4.8854	2.7750	28.5518	93.1413	13.940	-1.734	1.036	49.725	41.784	1.190	1.149	7.902	
-2.8	-4.6746	2.6827	27.6898	91.0299	14.066	-1.646	1.032	43.728	36.660	1.193	1.156	7.866	
-2.6	-4.4687	2.6561	26.9484	89.0571	14.187	-1.559	1.028	38.234	31.950	1.197	1.164	7.840	
-2.4	-4.2635	2.6248	26.3182	87.2111	14.304	-1.479	1.024	33.346	27.740	1.202	1.174	7.826	
-2.2	-4.0591	2.5983	25.7868	85.4772	14.419	-1.407	1.020	29.142	24.099	1.209	1.185	7.823	
-2.0	-3.8553	2.5758	25.3368	83.8390	14.529	-1.347	1.018	25.674	21.079	1.218	1.197	7.828	
-1.8	-3.6520	2.5564	24.9574	82.2750	14.637	-1.301	1.015	22.980	18.719	1.228	1.209	7.838	
-1.6	-3.4481	2.5394	24.6242	80.7685	14.744	-1.270	1.014	21.107	17.067	1.237	1.220	7.846	
-1.4	-3.2446	2.5234	24.3184	79.2989	14.849	-1.258	1.014	20.143	16.203	1.243	1.226	7.843	
-1.2	-3.0436	2.5072	24.0157	77.8359	14.953	-1.269	1.015	20.253	16.271	1.245	1.227	7.819	
-1.0	-2.8404	2.4861	23.6854	76.3551	15.055	-1.311	1.017	21.671	17.468	1.241	1.220	7.767	
-0.8	-2.6365	2.4668	23.2394	74.9177	15.156	-1.391	1.022	24.720	20.052	1.233	1.206	7.689	
-0.6	-2.4314	2.4374	22.7799	73.5187	15.254	-1.521	1.030	29.733	24.260	1.226	1.190	7.592	
-0.4	-2.2242	2.3985	22.1016	71.8665	15.351	-1.708	1.041	36.849	30.131	1.223	1.175	7.482	
-0.2	-2.0147	2.3496	21.2008	69.3927	15.445	-1.950	1.056	45.719	37.270	1.227	1.162	7.360	
0.	-1.8036	2.2777	20.0437	67.1705	15.536	-2.227	1.072	55.174	44.637	1.236	1.153	7.224	
0.2	-1.5886	2.1848	18.6384	64.7348	15.623	-2.496	1.088	63.267	50.702	1.248	1.147	7.072	
0.4	-1.3789	2.1010	17.0511	62.1830	15.707	-2.699	1.101	67.891	53.987	1.258	1.143	6.907	
0.6	-1.1745	2.0137	15.3861	59.4561	15.789	-2.748	1.106	67.865	53.790	1.262	1.141	6.738	
0.8	-0.9745	1.9074	13.7726	57.0545	15.873	-2.750	1.104	63.467	50.428	1.259	1.140	6.574	
1.0	-0.7707	1.8210	12.3465	54.7508	15.961	-2.605	1.096	56.199	44.930	1.251	1.141	6.426	
1.2	-0.5624	1.7455	11.1118	52.4947	16.058	-2.396	1.085	47.757	38.508	1.240	1.143	6.300	
1.4	-0.3570	1.6845	10.0944	50.8917	16.167	-2.169	1.072	39.554	32.156	1.230	1.148	6.199	
1.6	-0.1527	1.6445	9.2877	49.3172	16.285	-1.957	1.060	32.400	26.496	1.223	1.153	6.121	
1.8	0.0532	1.6135	8.6461	47.7327	16.412	-1.776	1.051	26.581	21.795	1.220	1.161	6.064	
2.0	0.2602	1.5895	8.1260	46.6976	16.543	-1.623	1.043	22.081	18.074	1.221	1.170	6.022	

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_{II} = 35.828$]

T = 7800 K													
$\log_{10} \frac{p}{p_0}$	$\log_{10} \frac{\rho}{\rho_0}$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_e$	$\frac{T}{p} \left(\frac{\partial p}{\partial T} \right)_p$	$\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p} \right)_T$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$	
-5.0	-7.3410	3.4452	52.4444	133.0277	12.522	-3.464	1.106	231.441	189.680	1.220	1.103	9.306	
-4.8	-6.8201	3.6676	46.7439	127.1024	12.631	-3.367	1.102	212.056	174.326	1.216	1.104	9.087	
-4.6	-6.2704	3.9053	44.9913	121.5944	12.836	-3.175	1.094	186.573	154.284	1.209	1.105	8.890	
-4.4	-5.6970	3.3641	41.7380	116.3593	12.989	-2.934	1.084	159.647	132.942	1.201	1.108	8.718	
-4.2	-5.1607	2.2438	38.9837	112.5864	13.141	-2.687	1.074	134.543	112.745	1.193	1.111	8.573	
-4.0	-5.3528	3.1414	36.6739	108.9048	13.291	-2.464	1.065	113.030	95.138	1.188	1.115	8.454	
-3.8	-5.7405	3.0536	34.7236	105.4287	13.441	-2.279	1.058	95.703	80.719	1.186	1.120	8.354	
-3.6	-6.5294	2.6768	33.0538	102.3707	13.589	-2.134	1.053	82.259	69.386	1.186	1.126	8.269	
-3.4	-6.2193	2.6084	31.5692	99.5603	13.733	-2.019	1.048	71.835	60.523	1.187	1.132	8.195	
-3.2	-5.1100	2.8467	30.3131	96.9503	13.874	-1.922	1.045	63.399	53.328	1.189	1.138	8.129	
-3.0	-4.4015	2.7911	29.1754	94.5145	14.009	-1.931	1.041	56.112	47.119	1.191	1.144	8.071	
-2.8	-4.4937	2.7416	28.1743	92.2396	14.140	-1.741	1.037	49.510	41.499	1.193	1.151	8.022	
-2.6	-4.4349	2.6931	27.3038	90.1189	14.265	-1.650	1.033	43.445	36.331	1.196	1.158	7.983	
-2.4	-4.4247	2.6605	26.5564	88.1358	14.386	-1.562	1.028	37.940	31.625	1.200	1.167	7.956	
-2.2	-4.4754	2.6243	25.9221	86.2349	14.503	-1.481	1.024	33.070	27.442	1.205	1.176	7.941	
-2.0	-5.1708	2.6011	25.3875	84.5453	14.617	-1.405	1.021	28.896	23.837	1.212	1.187	7.937	
-1.8	-5.1670	2.5700	24.9372	82.3027	14.728	-1.349	1.018	25.459	20.852	1.221	1.199	7.942	
-1.6	-5.4636	2.5582	24.5584	81.3371	14.837	-1.302	1.016	22.786	18.517	1.231	1.212	7.951	
-1.4	-5.2508	2.5407	24.2195	79.8285	14.944	-1.271	1.014	20.927	16.880	1.240	1.222	7.959	
-1.2	-5.0570	2.5243	23.9128	78.3555	15.049	-1.259	1.014	19.960	16.016	1.246	1.229	7.955	
-1.0	-4.7550	2.5077	23.6092	76.8932	15.153	-1.270	1.015	20.035	16.052	1.248	1.230	7.931	
-0.8	-4.4517	2.4891	23.2788	75.4121	15.255	-1.311	1.016	21.391	17.189	1.244	1.223	7.879	
-0.6	-4.4477	2.4692	22.8630	73.8751	15.356	-1.360	1.023	26.327	19.665	1.237	1.210	7.800	
-0.4	-4.4444	2.4474	22.3748	72.2377	15.454	-1.519	1.031	29.159	23.702	1.230	1.194	7.702	
-0.2	-4.4432	2.4242	21.8295	70.4493	15.551	-1.704	1.042	36.002	29.322	1.228	1.178	7.589	
0	-4.4424	2.4000	21.2400	68.4630	15.646	-1.943	1.057	44.434	36.121	1.232	1.166	7.463	
0.2	-4.4414	2.3735	20.6052	66.2537	15.737	-2.215	1.073	53.477	43.085	1.241	1.156	7.323	
0.4	-4.4411	2.3457	20.0000	63.8348	15.825	-2.476	1.089	61.060	48.737	1.253	1.150	7.167	
0.6	-4.4410	2.3166	19.4166	61.2937	15.910	-2.669	1.101	65.254	51.699	1.262	1.146	6.998	
0.8	-4.4410	2.2866	18.8542	58.7313	15.994	-2.751	1.107	64.999	51.349	1.266	1.144	6.825	
1.0	-4.4410	2.2566	18.3119	56.1593	16.079	-2.707	1.104	60.654	48.037	1.263	1.143	6.658	
1.2	-4.4410	2.2266	17.7900	53.5710	16.170	-2.562	1.096	53.031	42.761	1.254	1.144	6.508	
1.4	-4.4410	2.1966	17.2881	51.0000	16.269	-2.358	1.084	45.590	36.663	1.243	1.147	6.381	
1.6	-4.4410	2.1666	16.8000	48.4444	16.378	-2.138	1.072	37.826	30.666	1.233	1.151	6.279	
1.8	-4.4410	2.1366	16.3333	45.8889	16.497	-1.933	1.060	31.076	25.338	1.226	1.157	6.199	
2.0	-4.4410	2.1066	15.8889	43.3333	16.623	-1.759	1.051	25.598	20.921	1.224	1.164	6.140	
T = 9000 K													
-5.0	-7.7746	4.0114	57.4235	139.9093	12.556	-3.337	1.103	228.893	187.579	1.220	1.107	9.732	
-4.8	-7.2575	4.2561	51.0313	132.6715	12.721	-3.416	1.106	225.045	183.976	1.223	1.106	9.497	
-4.6	-6.7366	4.5132	44.8432	126.7214	12.881	-3.355	1.104	209.091	171.225	1.221	1.106	9.270	
-4.4	-6.2103	4.7840	40.9249	121.2436	13.037	-3.190	1.097	185.965	155.078	1.215	1.108	9.063	
-4.2	-5.6878	4.0744	41.6555	116.3131	13.190	-2.966	1.088	160.417	132.920	1.207	1.110	8.881	
-4.0	-5.1611	3.2709	38.8643	111.5513	13.341	-2.727	1.078	135.924	113.348	1.199	1.113	8.726	
-3.8	-5.7407	3.1427	36.4751	108.0104	13.491	-2.463	1.066	114.471	95.920	1.193	1.117	8.596	
-3.6	-6.5295	2.6781	34.4848	104.6235	13.640	-2.313	1.061	96.881	81.455	1.190	1.122	8.489	
-3.4	-6.2193	2.6084	32.7370	101.5133	13.787	-2.181	1.055	83.016	69.788	1.190	1.128	8.398	
-3.2	-5.1110	2.8431	31.2452	98.6019	13.931	-2.038	1.050	72.147	60.604	1.190	1.134	8.319	
-3.0	-4.4022	2.7941	29.9348	95.9233	14.070	-1.934	1.046	63.335	53.130	1.192	1.140	8.249	
-2.8	-4.4934	2.7450	28.7849	93.5710	14.205	-1.938	1.042	55.793	46.729	1.194	1.146	8.188	
-2.6	-4.4954	2.7461	27.7765	91.2667	14.335	-1.743	1.038	49.093	41.009	1.196	1.153	8.138	
-2.4	-4.4963	2.7010	26.8027	89.0146	14.461	-1.651	1.033	42.938	35.814	1.199	1.160	8.098	
-2.2	-4.4921	2.6692	26.1566	87.1755	14.581	-1.562	1.029	37.442	31.128	1.203	1.169	8.070	
-2.0	-5.1867	2.6395	25.5207	85.3228	14.698	-1.480	1.025	32.014	26.592	1.208	1.179	8.055	
-1.8	-5.4821	2.6067	24.9872	83.5844	14.812	-1.408	1.021	28.497	23.445	1.215	1.190	8.050	
-1.6	-5.4782	2.5792	24.5370	81.9422	14.923	-1.348	1.018	25.120	20.519	1.224	1.202	8.054	
-1.4	-5.2749	2.5581	24.1586	80.3767	15.032	-1.301	1.016	22.507	18.241	1.234	1.214	8.063	
-1.2	-5.0717	2.5417	23.8214	78.8604	15.139	-1.271	1.015	20.694	16.649	1.243	1.225	8.070	
-1.0	-4.7684	2.5244	23.5143	77.3548	15.244	-1.259	1.014	19.764	15.817	1.250	1.232	8.066	
-0.8	-4.4650	2.5073	23.2095	75.8314	15.348	-1.271	1.015	19.869	15.877	1.251	1.232	8.040	
-0.6	-4.4636	2.4821	22.8784	74.4479	15.450	-1.314	1.018	21.239	17.012	1.248	1.226	7.987	
-0.4	-4.4646	2.4645	22.4706	72.9076	15.551	-1.395	1.024	24.138	19.453	1.241	1.212	7.906	
-0.2	-4.4626	2.4435	21.9527	71.2655	15.650	-1.525	1.032	28.891	23.403	1.235	1.196	7.804	
0	-4.4616	2.4215	21.3810	69.4722	15.747	-1.711	1.044	35.564	28.851	1.233	1.181	7.688	
0.2	-4.4616	2.3963	20.8312	67.4832	15.841	-1.949	1.059	43.749	35.362	1.237	1.169	7.558	
0.4	-4.4616	2.3687	19.2351	65.2767	15.933	-2.216	1.075	52.264	41.516	1.247	1.160	7.414	
0.6	-4.4616	2.3403	17.8593	62.8737	16.021	-2.467	1.091	59.245	47.084	1.258	1.153	7.253	
0.8	-4.4616	2.3117	16.5920	60.3570	16.107	-2.647	1.103	62.849	49.603	1.267	1.149	7.079	
1.0	-4.4616	2.2833	15.3376	57.8353	16.193	-2.714	1.107	62.190	48.975	1.270	1.147	6.903	
1.2	-4.4616	2.2550	14.0928	55.4291	16.280	-2.661	1.104	57.739	45.611	1.266	1.146	6.734	
1.4	-4.4616	2.2266	12.8649	53.2215	16.373	-2.513	1.096	50.901	40.494	1.257	1.147	6.583	
1.6	-4.4616	2.1982	11.6516	51.2551	16.474	-2.312	1.084	43.236	34.094	1.246	1.150	6.455	
1.8	-4.4616	2.1716	10.4527	49.4278	16.585	-2.098	1.072	35.920	29.051	1.236	1.154	6.352	
2.0	-4.4616	2.1457	9.2811	47.8014	16.704	-1.902	1.060	29.605	24.072	1.230	1.160	6.272	

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[80% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 8200 K													
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{s}{R}$	$\log_{10} n_0$	$\frac{T(\theta p)}{p(\theta p)_T}$	$\frac{p(\theta p)}{p(\theta p)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$	
-5.0	-7.1127	4.3183	61.3490	144.2577	12.579	-3.008	1.090	204.764	168.931	1.212	1.112	10.146	
-4.8	-6.8935	4.1311	57.1873	138.1901	12.751	-3.252	1.101	218.453	178.772	1.222	1.110	9.914	
-4.6	-6.6726	3.9373	52.8796	132.0239	12.918	-3.361	1.106	217.715	177.517	1.226	1.109	9.675	
-4.4	-6.4514	3.7495	48.7110	126.0859	13.079	-3.330	1.105	204.631	167.006	1.225	1.109	9.442	
-4.2	-6.2305	3.5769	44.6890	120.5781	13.235	-3.189	1.099	183.685	150.585	1.220	1.110	9.226	
-4.0	-6.0120	3.4241	41.5218	115.5933	13.388	-2.982	1.090	159.562	131.637	1.212	1.112	9.035	
-3.6	-5.7945	3.2523	38.6357	111.1675	13.540	-2.751	1.080	135.864	112.798	1.204	1.115	8.872	
-3.6	-5.7998	3.1795	36.1933	107.2352	13.689	-2.530	1.071	114.748	95.748	1.198	1.119	8.734	
-3.4	-5.5664	3.0829	34.1305	103.7311	13.837	-2.338	1.063	97.172	81.325	1.195	1.124	8.619	
-3.2	-5.3544	2.9989	32.3720	100.5730	13.983	-2.180	1.057	83.120	69.635	1.194	1.129	8.522	
-3.0	-5.1435	2.9248	30.8533	97.6905	14.126	-2.051	1.052	71.982	60.281	1.194	1.135	8.438	
-2.8	-4.9336	2.8589	29.5285	95.0342	14.265	-1.941	1.047	62.917	52.630	1.195	1.142	8.365	
-2.6	-4.7246	2.8002	28.3690	92.5720	14.399	-1.840	1.043	55.188	46.098	1.197	1.148	8.303	
-2.4	-4.5165	2.7484	27.3550	90.2840	14.528	-1.742	1.038	48.350	40.314	1.199	1.155	8.251	
-2.2	-4.3103	2.7032	26.4874	88.1579	14.653	-1.648	1.034	42.215	35.117	1.202	1.163	8.210	
-2.0	-4.1050	2.6643	25.7435	86.1783	14.773	-1.558	1.029	36.754	30.473	1.206	1.172	8.182	
-1.8	-3.9076	2.6312	25.1146	84.3304	14.890	-1.476	1.025	31.995	26.405	1.212	1.182	8.166	
-1.6	-3.7229	2.6032	24.5858	82.5954	15.004	-1.404	1.021	27.962	22.938	1.219	1.193	8.162	
-1.4	-3.5489	2.5775	24.1408	80.9583	15.115	-1.345	1.018	24.673	20.095	1.228	1.206	8.166	
-1.2	-3.3855	2.5550	23.7616	79.3959	15.223	-1.299	1.016	22.148	17.898	1.237	1.218	8.174	
-1.0	-3.2324	2.5365	23.4293	77.8895	15.330	-1.270	1.015	20.419	16.380	1.247	1.228	8.180	
-0.8	-3.0895	2.5237	23.1273	76.4162	15.435	-1.260	1.015	18.567	15.618	1.253	1.235	8.174	
-0.6	-2.9564	2.5061	22.8155	74.9513	15.539	-1.275	1.016	19.747	15.740	1.255	1.235	8.146	
-0.4	-2.8329	2.4841	22.4776	73.4637	15.641	-1.320	1.019	21.173	16.925	1.251	1.228	8.089	
-0.2	-2.7186	2.4614	22.0694	71.9161	15.742	-1.405	1.025	24.134	19.396	1.244	1.214	8.005	
0.0	-2.6128	2.4388	21.5434	70.2637	15.841	-1.539	1.034	28.892	23.326	1.239	1.198	7.900	
0.2	-2.5149	2.3952	20.6464	68.4578	15.938	-1.728	1.046	35.474	28.662	1.238	1.183	7.780	
0.4	-2.4243	2.3275	19.9310	66.4567	16.032	-1.966	1.061	43.395	34.915	1.243	1.171	7.646	
0.6	-2.3394	2.2541	18.7742	64.2443	16.124	-2.228	1.078	51.419	41.039	1.253	1.162	7.495	
0.8	-2.2594	2.1667	17.3988	61.8505	16.213	-2.466	1.093	57.711	45.656	1.264	1.156	7.329	
1.0	-2.1834	2.0695	15.8816	59.3576	16.300	-2.629	1.104	60.594	47.638	1.272	1.152	7.151	
1.2	-2.1114	1.9710	14.3344	56.8890	16.386	-2.678	1.108	59.404	46.641	1.274	1.150	6.972	
1.4	-2.0434	1.8769	12.8656	54.5294	16.476	-2.612	1.104	54.758	43.160	1.269	1.149	6.801	
1.6	-1.9794	1.7828	11.5693	52.3836	16.571	-2.458	1.095	48.059	38.164	1.259	1.150	6.650	
1.8	-1.9194	1.7210	10.4680	50.4748	16.674	-2.259	1.083	40.759	32.649	1.248	1.153	6.523	
2.0	-1.8624	1.6612	9.5635	48.7970	16.786	-2.053	1.071	35.904	27.364	1.239	1.157	6.420	
T = 8400 K													
-5.0	-7.1420	4.5094	64.3310	148.7960	12.593	-2.578	1.073	167.125	139.180	1.201	1.120	10.531	
-4.8	-6.9259	4.3453	60.7609	143.1868	12.772	-2.919	1.088	193.418	159.393	1.213	1.115	10.317	
-4.6	-6.7070	4.1801	56.7328	137.1990	12.945	-3.176	1.100	208.594	170.437	1.224	1.113	10.083	
-4.4	-6.4883	3.9662	52.5187	131.1133	13.113	-3.305	1.106	210.036	170.858	1.229	1.111	9.840	
-4.2	-6.2656	3.7766	48.3993	125.2120	13.274	-3.207	1.106	199.190	162.062	1.229	1.111	9.602	
-4.0	-6.0443	3.6006	44.5881	119.7025	13.431	-3.176	1.101	180.111	147.117	1.224	1.112	9.380	
-3.8	-5.8244	3.4440	41.2091	114.7020	13.585	-2.982	1.092	157.355	129.300	1.217	1.114	9.181	
-3.6	-5.6075	3.3031	38.2960	110.2368	13.736	-2.761	1.083	134.557	111.258	1.209	1.117	9.010	
-3.4	-5.3919	3.1816	35.8260	106.2697	13.885	-2.544	1.073	113.967	94.718	1.203	1.121	8.865	
-3.2	-5.1781	3.0615	32.7360	102.7328	14.032	-2.352	1.065	96.617	80.559	1.199	1.126	8.744	
-3.0	-4.9657	2.9047	31.9547	99.5484	14.177	-2.192	1.059	82.581	68.947	1.198	1.131	8.641	
-2.8	-4.7545	2.8285	30.4207	96.6484	14.319	-2.058	1.053	71.337	59.554	1.198	1.137	8.554	
-2.6	-4.5444	2.7610	29.0881	93.9830	14.456	-1.943	1.048	62.130	51.823	1.199	1.144	8.478	
-2.4	-4.3352	2.6912	27.9284	91.5200	14.590	-1.838	1.043	54.293	45.226	1.200	1.150	8.414	
-2.2	-4.1270	2.6486	26.9228	89.2367	14.718	-1.737	1.039	47.406	39.422	1.203	1.158	8.361	
-2.0	-3.9197	2.6030	26.0588	87.1177	14.842	-1.641	1.034	41.287	34.251	1.205	1.166	8.320	
-1.8	-3.7134	2.5639	25.3241	85.1473	14.962	-1.550	1.029	35.893	29.674	1.210	1.175	8.292	
-1.6	-3.5079	2.5307	24.7045	83.3088	15.078	-1.468	1.025	31.232	25.698	1.215	1.185	8.277	
-1.4	-3.3033	2.4926	24.1841	81.5836	15.192	-1.398	1.022	27.310	22.334	1.223	1.197	8.272	
-1.2	-3.0993	2.5787	23.7460	79.9526	15.302	-1.339	1.019	24.133	19.592	1.232	1.209	8.277	
-1.0	-2.8956	2.5582	23.3722	78.3962	15.411	-1.296	1.016	21.728	17.502	1.241	1.221	8.285	
-0.8	-2.6927	2.5358	23.0420	76.8931	15.517	-1.269	1.015	20.112	16.086	1.250	1.232	8.289	
-0.6	-2.4897	2.5272	22.7362	75.4207	15.622	-1.261	1.015	19.375	15.422	1.256	1.238	8.280	
-0.4	-2.2865	2.5040	22.4262	73.9534	15.726	-1.279	1.017	19.675	15.645	1.258	1.237	8.248	
-0.2	-2.0829	2.4630	22.0903	72.4596	15.828	-1.329	1.020	21.225	16.928	1.254	1.229	8.187	
0.0	-1.8792	2.4569	21.6599	70.9011	15.928	-1.419	1.026	24.302	19.481	1.247	1.215	8.099	
0.2	-1.6721	2.4223	21.1153	69.2326	16.027	-1.560	1.036	29.135	23.446	1.243	1.200	7.990	
0.4	-1.4637	2.3760	20.3948	67.4067	16.124	-1.754	1.049	35.681	28.710	1.243	1.185	7.865	
0.6	-1.2525	2.3152	19.4545	65.3856	16.219	-1.993	1.064	43.354	34.712	1.249	1.173	7.725	
0.8	-1.0370	2.2388	18.2749	63.1608	16.311	-2.249	1.081	50.839	40.369	1.259	1.165	7.568	
1.0	-0.8201	2.1489	16.8958	60.7710	16.400	-2.472	1.098	56.348	44.367	1.270	1.159	7.396	
1.2	-0.5958	2.0510	15.4006	58.3045	16.438	-2.612	1.106	58.401	45.740	1.277	1.155	7.213	
1.4	-0.3784	1.9521	13.8932	55.8754	16.576	-2.640	1.108	56.598	44.319	1.277	1.153	7.031	
1.6	-0.1572	1.8553	12.4836	53.5837	16.667	-2.558	1.103	51.718	40.690	1.271	1.152	6.861	
1.8	0.0624	1.7770	11.2427	51.5108	16.765	-2.397	1.093	45.147	35.804	1.261	1.153	6.710	
2.0	0.2799	1.7070	10.1996	49.6651	16.870	-2.201	1.081	38.219	30.571	1.250	1.156	6.584	

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 8600 K												
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_e$	$\frac{T}{p} \left(\frac{\partial p}{\partial T} \right)_p$	$\frac{p}{\rho} \left(\frac{\partial \rho}{\partial p} \right)_T$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$
-5.0	-7.1661	4.6562	66.2513	152.2540	12.599	-2.155	1.054	127.208	106.695	1.192	1.131	10.882
-4.8	-6.9536	4.5243	63.4407	147.3289	12.784	-2.509	1.071	157.768	131.177	1.203	1.123	10.690
-4.6	-6.7378	4.3627	60.0000	141.6408	12.964	-2.848	1.087	183.766	151.208	1.215	1.118	10.475
-4.4	-6.5192	4.1791	56.0905	135.6537	13.138	-3.111	1.099	199.590	162.785	1.226	1.115	10.239
-4.2	-6.2986	3.9854	51.9694	129.9627	13.306	-3.253	1.106	202.377	164.243	1.232	1.114	9.993
-4.0	-6.0772	3.7944	47.9098	124.1121	13.468	-3.260	1.106	193.128	156.684	1.233	1.114	9.750
-3.8	-5.8564	3.6162	44.1318	118.6280	13.625	-3.153	1.102	175.556	142.927	1.228	1.115	9.522
-3.6	-5.6368	3.4569	40.7664	113.6345	13.779	-2.972	1.094	154.054	126.135	1.221	1.117	9.318
-3.4	-5.4150	3.3181	37.8555	109.1646	13.929	-2.759	1.084	132.200	108.901	1.214	1.120	9.140
-3.2	-5.2031	3.1987	35.3765	105.1856	14.078	-2.547	1.075	112.256	92.949	1.208	1.123	8.990
-3.0	-4.9885	3.0960	33.2757	101.6361	14.224	-2.357	1.067	95.293	79.171	1.204	1.128	8.863
-2.8	-4.7762	3.0070	31.4860	98.4417	14.368	-2.195	1.060	81.433	67.761	1.202	1.134	8.756
-2.6	-4.5648	2.9290	29.9483	95.5376	14.509	-2.059	1.054	70.223	58.442	1.202	1.140	8.665
-2.4	-4.3545	2.8603	28.6176	92.8742	14.645	-1.940	1.049	60.983	50.718	1.202	1.146	8.587
-2.2	-4.1452	2.7998	27.4644	90.4180	14.778	-1.831	1.044	53.113	44.120	1.204	1.153	8.521
-2.0	-3.9365	2.7469	26.4699	88.1467	14.905	-1.728	1.039	46.235	38.341	1.206	1.161	8.468
-1.8	-3.7256	2.7011	25.6109	86.0414	15.029	-1.630	1.034	40.174	33.234	1.209	1.169	8.427
-1.6	-3.5233	2.6620	24.8979	84.0856	15.148	-1.539	1.029	34.881	28.752	1.213	1.179	8.400
-1.4	-3.3179	2.6289	24.2913	82.2610	15.263	-1.458	1.025	30.343	24.889	1.219	1.189	8.385
-1.2	-3.1152	2.6005	23.7826	80.5483	15.376	-1.389	1.021	26.559	21.648	1.227	1.201	8.382
-1.0	-2.9092	2.5771	23.3540	78.9276	15.486	-1.333	1.019	23.533	19.040	1.236	1.213	8.386
-0.8	-2.7057	2.5565	22.9871	77.3788	15.594	-1.291	1.016	21.263	17.069	1.246	1.225	8.394
-0.6	-2.5024	2.5379	22.6617	75.8904	15.701	-1.267	1.015	19.790	15.778	1.254	1.235	8.396
-0.4	-2.2985	2.5199	22.3552	74.4604	15.805	-1.264	1.016	19.208	15.246	1.260	1.240	8.384
-0.2	-2.0952	2.5009	22.0405	72.9385	15.909	-1.286	1.018	19.665	15.601	1.260	1.239	8.347
0.	-1.8923	2.4787	21.6846	71.4361	16.011	-1.341	1.022	21.390	17.023	1.256	1.230	8.280
0.2	-1.6874	2.4507	21.2462	69.8621	16.111	-1.439	1.028	24.662	19.706	1.250	1.216	8.186
0.4	-1.4818	2.4136	20.6764	68.1719	16.210	-1.588	1.038	29.605	23.746	1.247	1.201	8.072
0.6	-1.2718	2.3641	19.9241	66.3189	16.307	-1.788	1.052	36.144	28.957	1.248	1.186	7.942
0.8	-1.0597	2.2956	18.9510	64.2714	16.401	-2.029	1.068	43.550	34.689	1.255	1.175	7.796
1.0	-0.8444	2.2197	17.7505	62.0297	16.493	-2.276	1.085	50.425	39.826	1.266	1.167	7.632
1.2	-0.6259	2.1272	16.3656	59.6435	16.583	-2.481	1.099	55.049	43.137	1.276	1.161	7.453
1.4	-0.4052	2.0281	14.8958	57.2067	16.672	-2.595	1.107	56.191	43.852	1.281	1.158	7.266
1.6	-0.1836	1.9298	13.4229	54.8327	16.762	-2.597	1.108	53.741	41.985	1.280	1.156	7.082
1.8	0.0374	1.8387	11.9738	52.4162	16.855	-2.498	1.102	46.627	36.208	1.273	1.155	6.912
2.0	0.2567	1.7587	10.8929	50.6130	16.955	-2.332	1.091	42.206	33.440	1.262	1.157	6.763
T = 8800 K												
-5.0	-7.1858	4.7616	67.2329	154.7720	12.600	-1.806	1.039	92.909	77.962	1.192	1.147	11.213
-4.8	-6.9767	4.6422	65.1505	150.5242	12.790	-2.114	1.053	121.026	101.250	1.195	1.135	11.034
-4.6	-6.7646	4.5316	62.4415	145.6312	12.975	-2.452	1.070	150.397	124.779	1.205	1.126	10.839
-4.4	-6.5497	4.4217	59.1015	140.3003	13.155	-2.794	1.086	175.711	144.286	1.218	1.121	10.621
-4.2	-6.3302	4.3189	55.2800	134.5166	13.330	-3.058	1.099	191.541	155.885	1.229	1.118	10.383
-4.0	-6.1096	4.2253	51.2545	128.5968	13.498	-3.205	1.106	194.957	157.842	1.235	1.117	10.134
-3.8	-5.8893	4.1355	47.2526	122.4091	13.660	-3.221	1.107	186.724	151.080	1.236	1.117	9.886
-3.6	-5.6673	4.0461	43.5361	117.3733	13.817	-3.124	1.102	170.309	138.233	1.232	1.118	9.654
-3.4	-5.4475	3.9625	40.2036	112.4092	13.971	-2.952	1.095	149.890	122.326	1.225	1.119	9.444
-3.2	-5.2295	3.8821	37.3137	107.3579	14.121	-2.747	1.085	128.969	105.877	1.218	1.122	9.262
-3.0	-5.0133	3.8007	34.8467	103.9894	14.269	-2.540	1.076	109.752	90.561	1.212	1.126	9.107
-2.8	-4.7985	3.7252	32.7527	100.4465	14.414	-2.353	1.068	93.297	77.247	1.208	1.131	8.976
-2.6	-4.5860	3.6507	30.9689	97.2591	14.557	-2.192	1.061	79.741	66.136	1.206	1.136	8.865
-2.4	-4.3744	3.5765	29.4383	94.3618	14.697	-2.053	1.055	68.677	56.980	1.205	1.142	8.771
-2.2	-4.1640	3.5030	28.1183	91.7105	14.832	-1.932	1.049	59.494	49.336	1.206	1.149	8.692
-2.0	-3.9546	3.4311	26.9787	89.2706	14.963	-1.820	1.044	51.666	42.798	1.207	1.156	8.625
-1.8	-3.7463	3.3601	26.0022	87.0178	15.090	-1.714	1.039	44.852	37.091	1.209	1.164	8.572
-1.6	-3.5390	3.2905	25.1695	84.9320	15.212	-1.616	1.034	38.895	32.082	1.212	1.173	8.532
-1.4	-3.3328	3.2227	24.4668	82.9969	15.320	-1.526	1.029	33.738	27.724	1.217	1.182	8.506
-1.2	-3.1274	3.1569	23.8769	81.1902	15.445	-1.446	1.025	29.355	23.998	1.223	1.193	8.492
-1.0	-2.9227	3.0927	23.3825	79.4932	15.568	-1.378	1.021	25.735	20.902	1.231	1.206	8.490
-0.8	-2.7188	3.0296	22.9655	77.8854	15.667	-1.325	1.018	22.875	18.440	1.241	1.218	8.495
-0.6	-2.5153	2.9670	22.6057	76.3456	15.775	-1.286	1.017	20.771	16.615	1.250	1.230	8.502
-0.4	-2.3121	2.9052	22.2854	74.8524	15.881	-1.265	1.016	19.469	15.472	1.258	1.239	8.501
-0.2	-2.1095	2.8441	21.9783	73.3923	15.986	-1.267	1.016	19.071	15.097	1.263	1.243	8.485
0.	-1.9055	2.7836	21.6572	71.9057	16.089	-1.295	1.019	19.731	15.620	1.263	1.240	8.441
0.2	-1.7013	2.7231	21.2875	70.3922	16.190	-1.358	1.023	21.680	17.221	1.259	1.230	8.368
0.4	-1.4960	2.6628	20.8258	68.7986	16.291	-1.466	1.031	25.161	20.072	1.254	1.216	8.268
0.6	-1.2898	2.6026	20.2235	67.0801	16.389	-1.624	1.042	30.289	24.211	1.251	1.201	8.148
0.8	-1.0790	2.5421	19.4318	65.1937	16.486	-1.831	1.056	36.823	29.364	1.254	1.187	8.011
1.0	-0.8661	2.4804	18.4191	63.1143	16.580	-2.072	1.073	43.907	34.782	1.262	1.177	7.857
1.2	-0.6498	2.4186	17.1902	60.9541	16.672	-2.308	1.089	50.070	39.329	1.273	1.169	7.686
1.4	-0.4306	2.3567	15.7999	58.4738	16.767	-2.489	1.102	53.711	41.895	1.282	1.163	7.501
1.6	-0.2095	2.2947	14.3446	56.0736	16.852	-2.574	1.108	53.897	41.926	1.286	1.160	7.310
1.8	0.0121	2.2326	12.8221	53.7986	16.940	-2.574	1.117	53.810	39.624	1.282	1.158	7.125
2.0	0.2325	2.1706	11.6492	51.6229	17.040	-2.434	1.100	45.505	35.725	1.274	1.158	6.956

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 9000 K												
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_e$	$\frac{T(\partial p)}{\rho(\partial T)_p}$	$\frac{p(\partial p)}{\rho(\partial p)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$
-5.0	-7.2021	4.8337	67.4996	156.5534	12.597	-1.546	1.027	67.023	55.773	1.202	1.170	11.539
-4.8	-6.9957	4.7622	66.0398	152.8832	12.790	-1.787	1.039	69.581	74.932	1.195	1.151	11.359
-4.6	-6.7865	4.6631	64.0145	148.6868	12.980	-2.089	1.053	116.535	97.215	1.199	1.138	11.176
-4.4	-6.5742	4.5329	61.3543	143.9077	13.166	-2.427	1.070	144.736	119.771	1.208	1.130	10.977
-4.2	-6.3586	4.3730	58.0852	138.5858	13.346	-2.756	1.086	169.099	138.515	1.221	1.124	10.756
-4.0	-6.1401	4.1902	54.3514	132.8804	13.520	-3.016	1.099	184.418	149.724	1.232	1.121	10.515
-3.8	-5.9125	3.9565	50.3948	127.0387	13.688	-3.163	1.106	187.872	151.726	1.238	1.120	10.262
-3.6	-5.6581	3.8043	46.4758	121.3235	13.850	-3.181	1.107	180.144	145.375	1.239	1.119	10.011
-3.4	-5.4771	3.6242	42.8127	115.9508	14.008	-3.089	1.103	164.539	133.179	1.235	1.120	9.775
-3.2	-5.2572	3.4622	39.5326	111.0400	14.161	-2.924	1.095	145.058	118.027	1.229	1.122	9.562
-3.0	-5.0390	3.3204	36.6811	106.6272	14.310	-2.725	1.086	125.028	102.322	1.222	1.125	9.376
-2.8	-4.8227	3.1979	34.2441	102.6901	14.458	-2.525	1.077	106.589	87.667	1.216	1.129	9.217
-2.6	-4.6081	3.0923	32.1719	99.1699	14.602	-2.341	1.069	90.725	74.876	1.212	1.134	9.083
-2.4	-4.3951	3.0008	30.4067	96.0023	14.744	-2.180	1.062	77.570	64.132	1.210	1.139	8.970
-2.2	-4.1834	2.9210	28.8944	93.1270	14.892	-2.042	1.055	66.744	55.209	1.209	1.145	8.874
-2.0	-3.9729	2.8512	27.5941	90.4984	15.048	-1.924	1.050	57.703	47.713	1.211	1.159	8.793
-1.8	-3.7635	2.7903	26.4770	88.0820	15.166	-1.804	1.044	49.979	41.285	1.213	1.168	8.726
-1.6	-3.5552	2.7376	25.5229	85.8554	15.271	-1.697	1.039	43.285	35.692	1.216	1.177	8.635
-1.4	-3.3480	2.6925	24.7138	83.7962	15.393	-1.599	1.034	37.474	30.816	1.216	1.177	8.549
-1.2	-3.1418	2.6542	24.0329	81.8845	15.510	-1.510	1.029	32.489	26.610	1.221	1.187	8.410
-1.0	-2.9365	2.6219	23.4627	80.0597	15.624	-1.432	1.025	28.292	23.047	1.228	1.198	8.598
-0.8	-2.7315	2.5946	22.9849	78.4209	15.736	-1.366	1.021	24.862	20.117	1.236	1.210	8.597
-0.6	-2.5280	2.5713	22.5810	76.8277	15.845	-1.316	1.018	22.186	17.815	1.245	1.223	8.603
-0.4	-2.3245	2.5507	22.2310	75.2983	15.953	-1.281	1.017	20.272	16.156	1.255	1.234	8.608
-0.2	-2.1213	2.5317	21.9138	73.8110	16.058	-1.265	1.016	19.169	15.183	1.263	1.243	8.604
0.0	-1.9180	2.5126	21.6047	72.3404	16.162	-1.272	1.017	18.989	14.992	1.267	1.245	8.581
0.2	-1.7143	2.4915	21.2743	70.8576	16.265	-1.308	1.020	19.892	15.716	1.266	1.241	8.530
0.4	-1.5098	2.4659	20.9359	69.3273	16.367	-1.380	1.025	22.110	17.530	1.261	1.230	8.449
0.6	-1.3040	2.4329	20.3954	67.7086	16.467	-1.498	1.034	25.861	20.578	1.257	1.216	8.362
0.8	-1.0960	2.3869	19.7533	65.9558	16.565	-1.667	1.046	31.173	24.824	1.256	1.201	8.216
1.0	-0.8854	2.3309	18.9151	64.0303	16.661	-1.882	1.061	37.669	29.887	1.260	1.188	8.072
1.2	-0.6714	2.2574	17.8577	61.9156	16.756	-2.121	1.078	44.338	34.922	1.270	1.178	7.910
1.4	-0.4542	2.1656	16.5968	59.5380	16.848	-2.341	1.094	49.672	38.801	1.280	1.170	7.731
1.6	-0.2343	2.0721	15.2082	57.2694	16.938	-2.549	1.105	52.246	40.575	1.288	1.166	7.539
1.8	-0.0128	1.9721	13.7840	54.9141	17.029	-2.744	1.109	51.466	39.927	1.289	1.162	7.345
2.0	0.2088	1.8765	12.4291	52.6733	17.123	-2.946	1.106	47.799	37.231	1.284	1.161	7.160
T = 9200 K												
-5.0	-7.2160	4.8817	67.2900	157.8155	12.592	-1.365	1.018	48.944	40.012	1.223	1.201	11.878
-4.8	-7.0115	4.8316	66.2776	154.5762	12.788	-1.542	1.027	65.636	54.445	1.206	1.174	11.681
-4.6	-6.8045	4.7553	64.8290	150.9181	12.981	-1.781	1.039	87.478	72.945	1.199	1.154	11.496
-4.4	-6.5957	4.6592	62.8223	146.7414	13.170	-2.079	1.054	113.477	94.376	1.202	1.141	11.309
-4.2	-6.3933	4.5280	60.1936	141.9964	13.356	-2.411	1.070	140.532	115.944	1.212	1.132	11.106
-4.0	-6.1676	4.3670	56.9643	136.7229	13.536	-2.732	1.086	163.734	133.734	1.224	1.127	10.881
-3.8	-5.9489	4.1856	53.2959	131.0796	13.710	-2.985	1.099	178.134	144.226	1.235	1.124	10.635
-3.6	-5.7283	3.9896	49.4419	125.3143	13.876	-3.126	1.106	181.133	145.896	1.242	1.122	10.379
-3.4	-5.5065	3.7973	45.5681	119.6771	14.039	-3.161	1.107	173.485	139.640	1.242	1.122	10.124
-3.2	-5.2858	3.6171	41.5777	114.7801	14.196	-3.051	1.103	158.393	127.873	1.239	1.123	9.885
-3.0	-5.0658	3.4551	38.7634	109.5381	14.349	-2.890	1.096	139.691	113.356	1.232	1.125	9.669
-2.8	-4.8476	3.3131	35.9680	105.1850	14.498	-2.696	1.087	120.526	98.356	1.225	1.128	9.481
-2.6	-4.6312	3.1903	33.5755	101.2957	14.644	-2.501	1.078	102.889	84.370	1.219	1.132	9.320
-2.4	-4.4165	3.0843	31.5397	97.8157	14.788	-2.321	1.069	87.680	72.140	1.215	1.137	9.184
-2.2	-4.2034	2.9925	29.8051	94.6826	14.928	-2.163	1.062	74.996	61.814	1.213	1.142	9.069
-2.0	-3.9917	2.9126	28.3209	91.8391	15.065	-2.024	1.056	64.477	53.176	1.213	1.149	8.971
-1.8	-3.7811	2.8429	27.0487	89.2419	15.198	-1.899	1.050	55.641	45.877	1.213	1.156	8.890
-1.6	-3.5718	2.7825	25.9605	86.8586	15.326	-1.783	1.044	48.087	39.609	1.214	1.163	8.824
-1.4	-3.3636	2.7304	25.0351	84.6642	15.450	-1.677	1.038	41.565	34.173	1.216	1.172	8.772
-1.2	-3.1565	2.6861	24.2537	82.6358	15.571	-1.578	1.033	35.943	29.464	1.220	1.181	8.736
-1.0	-2.9504	2.6486	23.5983	80.7524	15.687	-1.491	1.028	31.158	25.432	1.225	1.192	8.713
-0.8	-2.7452	2.6169	23.0503	78.9921	15.801	-1.415	1.024	27.169	22.050	1.232	1.203	8.704
-0.6	-2.5407	2.5902	22.5910	77.3341	15.912	-1.353	1.021	23.953	19.304	1.241	1.216	8.704
-0.4	-2.3368	2.5672	22.2010	75.7566	16.020	-1.306	1.018	21.487	17.184	1.250	1.228	8.709
-0.2	-2.1334	2.5468	21.8600	74.2381	16.127	-1.276	1.017	19.787	15.709	1.260	1.239	8.712
0.0	-1.9301	2.5274	21.5460	72.7553	16.232	-1.266	1.017	18.914	14.932	1.267	1.246	8.704
0.2	-1.7264	2.5076	21.2329	71.2833	16.336	-1.279	1.018	18.980	14.949	1.270	1.247	8.674
0.4	-1.5227	2.4850	20.8836	69.7903	16.439	-1.324	1.022	20.169	15.905	1.268	1.241	8.614
0.6	-1.3178	2.4571	20.4777	68.2402	16.540	-1.408	1.028	22.702	17.965	1.264	1.229	8.524
0.8	-1.1113	2.4206	19.9512	66.5903	16.640	-1.539	1.038	26.746	21.224	1.260	1.215	8.410
1.0	-0.9025	2.3721	19.2618	64.7967	16.738	-1.719	1.051	32.236	25.564	1.261	1.200	8.276
1.2	-0.6908	2.3090	18.3707	62.8271	16.834	-1.940	1.067	38.622	30.476	1.267	1.188	8.123
1.4	-0.4758	2.2304	17.2661	60.6768	16.928	-2.173	1.084	44.750	35.036	1.277	1.179	7.953
1.6	-0.2575	2.1386	15.9816	58.3858	17.020	-2.372	1.098	49.127	38.169	1.287	1.172	7.765
1.8	-0.0365	2.0393	14.5961	56.0382	17.111	-2.643	1.107	50.578	39.129	1.293	1.167	7.568
2.0	0.1849	1.9397	13.2120	53.7380	17.204	-2.912	1.109	48.873	37.838	1.292	1.165	7.372

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING
MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; p₀ = 1.01325 × 10⁵ N/m²; ρ₀ = 1.59842 kg/m³; R = 8.31469 J/mole-°K;
A₀ = 2.97904 × 10² m/sec; and M_u = 35.828]

T = 9400 K												
log ₁₀ p/p ₀	log ₁₀ ρ/ρ ₀	Z	H RT	S R	log ₁₀ N _e	T ρ(∂ρ) ρ(∂T) _p	P ρ(∂ρ) ρ(∂T) _T	C _p R	C _v R	γ	γ _E	A A ₀
-5.0	-7.2281	4.9133	66.7523	158.7298	12.586	-1.243	1.012	36.849	29.348	1.256	1.240	12.239
-4.8	-7.0250	4.8786	66.0717	155.7937	12.783	-1.369	1.019	48.651	39.679	1.226	1.204	12.014
-4.6	-6.8204	4.8271	65.0601	152.5466	12.978	-1.547	1.028	65.070	53.831	1.209	1.176	11.813
-4.4	-6.6137	4.7529	63.6024	148.8820	13.171	-1.786	1.040	86.420	71.846	1.203	1.157	11.624
-4.2	-6.4042	4.6507	61.5923	144.7063	13.360	-2.081	1.055	111.615	92.522	1.206	1.143	11.453
-4.0	-6.1916	4.5171	58.9668	139.9678	13.545	-2.408	1.072	137.546	113.105	1.216	1.135	11.225
-3.8	-5.9756	4.3541	55.7649	134.7218	13.725	-2.720	1.088	159.405	129.781	1.228	1.129	10.994
-3.6	-5.7568	4.1695	52.1376	129.1316	13.898	-2.962	1.100	172.542	139.278	1.239	1.126	10.744
-3.4	-5.5361	3.9749	48.3171	123.4356	14.065	-3.093	1.107	174.684	140.325	1.245	1.125	10.484
-3.2	-5.3146	3.7829	44.5554	117.8883	14.227	-3.102	1.107	166.782	133.904	1.246	1.125	10.227
-3.0	-5.0934	3.6033	41.0470	112.6793	14.383	-3.009	1.103	151.972	122.392	1.242	1.126	9.985
-2.8	-4.8735	3.4420	37.9118	107.9227	14.535	-2.850	1.096	133.930	108.411	1.235	1.128	9.768
-2.6	-4.6533	3.3006	35.1850	103.6441	14.684	-2.661	1.087	115.590	94.081	1.229	1.131	9.578
-2.4	-4.4389	3.1783	32.8509	99.8189	14.829	-2.471	1.078	98.772	80.768	1.223	1.135	9.416
-2.2	-4.2242	3.0725	30.8631	96.3924	14.972	-2.295	1.069	84.253	69.119	1.219	1.140	9.278
-2.0	-4.0111	2.9810	29.1695	93.3056	15.111	-2.139	1.062	72.086	59.244	1.217	1.146	9.162
-1.8	-3.7993	2.9015	27.7227	90.5046	15.246	-2.000	1.055	61.929	50.930	1.216	1.152	9.065
-1.6	-3.5889	2.8325	26.4865	87.9485	15.377	-1.875	1.049	53.359	43.871	1.216	1.159	8.984
-1.4	-3.3797	2.7729	25.4336	85.6052	15.504	-1.759	1.043	46.026	37.803	1.218	1.167	8.919
-1.2	-3.1716	2.7218	24.5420	83.4487	15.627	-1.652	1.038	39.720	32.558	1.220	1.176	8.870
-1.0	-2.9646	2.6785	23.7923	81.4559	15.746	-1.556	1.032	34.325	28.045	1.224	1.186	8.835
-0.8	-2.7587	2.6419	23.1653	79.6041	15.862	-1.471	1.028	29.773	24.213	1.230	1.197	8.816
-0.6	-2.5536	2.6112	22.6415	77.8709	15.974	-1.398	1.023	26.018	21.031	1.237	1.209	8.808
-0.4	-2.3492	2.5851	22.2017	76.2348	16.084	-1.340	1.020	23.033	18.485	1.246	1.221	8.809
-0.2	-2.1454	2.5625	21.8261	74.6741	16.192	-1.297	1.018	20.799	16.564	1.256	1.233	8.814
0.	-1.9419	2.5420	21.4937	73.1663	16.299	-1.272	1.017	19.335	15.290	1.265	1.243	8.815
0.2	-1.7395	2.5223	21.1817	71.6978	16.404	-1.268	1.017	18.717	14.730	1.271	1.249	8.801
0.4	-1.5345	2.5014	20.8614	70.2111	16.507	-1.250	1.019	19.070	14.985	1.273	1.248	8.761
0.6	-1.3306	2.4769	20.5008	68.7041	16.609	-1.345	1.024	20.583	16.204	1.270	1.241	8.692
0.8	-1.1252	2.4461	20.0589	67.1283	16.710	-1.442	1.031	23.466	18.533	1.266	1.228	8.593
1.0	-0.9179	2.4056	19.4891	65.4410	16.810	-1.587	1.042	27.820	22.007	1.264	1.213	8.470
1.2	-0.7092	2.3520	18.7451	63.6009	16.907	-1.779	1.056	33.444	26.398	1.267	1.199	8.327
1.4	-0.4953	2.2831	17.7960	61.5838	17.003	-2.003	1.073	39.609	31.072	1.275	1.188	8.165
1.6	-0.2790	2.1952	16.6445	59.3998	17.097	-2.225	1.089	45.044	35.053	1.285	1.180	7.985
1.8	-0.0597	2.1038	15.3400	57.1041	17.189	-2.398	1.102	48.341	37.371	1.294	1.173	7.790
2.0	0.1615	2.0033	13.9707	54.7891	17.281	-2.483	1.109	48.656	37.522	1.297	1.169	7.588
T = 9600 K												
-5.0	-7.2391	4.9340	66.0412	159.4170	12.579	-1.163	1.008	28.941	22.326	1.296	1.285	12.618
-4.8	-7.0370	4.9101	65.5803	156.6846	12.776	-1.250	1.013	37.088	29.513	1.257	1.241	12.366
-4.6	-6.8357	4.8739	64.8819	153.7369	12.973	-1.378	1.020	48.900	39.817	1.228	1.204	12.140
-4.4	-6.6285	4.8202	63.8666	150.4686	13.168	-1.560	1.029	65.228	53.834	1.212	1.171	11.937
-4.2	-6.4219	4.7432	62.3611	146.7802	13.360	-1.800	1.041	86.271	71.507	1.206	1.158	11.744
-4.0	-6.2122	4.6375	60.3230	142.5810	13.549	-2.095	1.057	110.788	91.522	1.211	1.145	11.548
-3.8	-5.9991	4.5005	57.6814	137.8339	13.734	-2.417	1.073	135.561	111.064	1.221	1.137	11.334
-3.6	-5.7928	4.3347	54.4842	132.6013	13.913	-2.719	1.089	155.894	126.468	1.233	1.132	11.098
-3.4	-5.5637	4.1482	50.8887	127.0518	14.086	-2.947	1.101	167.473	134.753	1.243	1.129	10.842
-3.2	-5.3428	3.9531	47.1309	121.4287	14.252	-3.064	1.107	168.450	134.938	1.248	1.127	10.578
-3.0	-5.1213	3.7617	43.4517	115.9738	14.413	-3.063	1.107	160.023	128.165	1.249	1.127	10.318
-2.8	-4.9002	3.5833	40.0355	110.8665	14.569	-2.964	1.103	145.333	116.781	1.244	1.128	10.075
-2.6	-4.6803	3.4234	36.9900	106.2095	14.720	-2.805	1.095	127.872	103.271	1.238	1.131	9.857
-2.4	-4.4622	3.2833	34.3441	102.0190	14.867	-2.620	1.086	110.333	89.584	1.232	1.134	9.667
-2.2	-4.2458	3.1621	32.0793	98.2709	15.012	-2.435	1.077	94.337	76.939	1.226	1.138	9.505
-2.0	-4.0312	3.0573	30.1501	94.9103	15.153	-2.263	1.069	80.532	65.884	1.222	1.143	9.367
-1.8	-3.8181	2.9666	28.5070	91.8807	15.291	-2.110	1.062	68.914	56.478	1.220	1.149	9.251
-1.6	-3.6065	2.8880	27.1058	89.1318	15.425	-1.972	1.055	59.162	48.518	1.219	1.156	9.154
-1.4	-3.3961	2.8201	25.9127	86.6247	15.554	-1.846	1.049	50.900	41.732	1.220	1.163	9.075
-1.2	-3.1870	2.7617	24.9004	84.3274	15.680	-1.731	1.042	43.835	35.898	1.221	1.171	9.012
-1.0	-2.9792	2.7120	24.0473	82.2143	15.801	-1.625	1.037	37.788	30.877	1.224	1.181	8.965
-0.8	-2.7724	2.6699	23.3324	80.2605	15.919	-1.531	1.031	32.652	26.585	1.228	1.191	8.934
-0.6	-2.5666	2.6345	22.7358	78.4427	16.033	-1.449	1.027	28.359	22.975	1.234	1.202	8.917
-0.4	-2.3616	2.6047	22.2377	76.7385	16.145	-1.380	1.023	24.859	20.011	1.242	1.215	8.912
-0.2	-2.1574	2.5793	21.8180	75.1252	16.254	-1.326	1.020	22.127	17.680	1.252	1.227	8.914
0.	-1.9536	2.5570	21.4566	73.5813	16.362	-1.288	1.018	20.143	15.972	1.261	1.239	8.918
0.2	-1.7501	2.5365	21.1315	72.0834	16.468	-1.270	1.017	18.939	14.920	1.269	1.248	8.914
0.4	-1.5465	2.5162	20.8182	70.6057	16.572	-1.273	1.018	18.607	14.599	1.274	1.252	8.892
0.6	-1.3427	2.4939	20.4878	69.1226	16.675	-1.305	1.021	19.282	15.120	1.275	1.249	8.843
0.8	-1.1381	2.4671	20.1043	67.5965	16.777	-1.373	1.026	21.159	16.629	1.272	1.240	8.762
1.0	-0.9320	2.4327	19.6254	65.9891	16.878	-1.484	1.035	24.418	19.241	1.269	1.226	8.653
1.2	-0.7238	2.3873	19.0042	64.2575	16.977	-1.644	1.047	29.069	22.911	1.269	1.212	8.521
1.4	-0.5128	2.3279	18.1989	62.3660	17.074	-1.846	1.063	34.747	27.281	1.274	1.199	8.369
1.6	-0.2986	2.2529	17.1856	60.3010	17.169	-2.069	1.080	40.537	31.606	1.283	1.188	8.197
1.8	-0.0811	2.1638	15.9951	58.0892	17.263	-2.273	1.095	45.108	34.896	1.293	1.180	8.007
2.0	0.1391	2.0654	14.6804	55.8005	17.356	-2.414	1.106	47.239	36.358	1.299	1.175	7.805

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T = 9800 K													
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_e$	$\frac{T(\rho p)}{p(\delta p)_T}$	$\frac{p(\rho p)}{p(\delta p)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{\Delta}{A_0}$	
-5.0	-7.2492	4.9477	65.2280	159.9570	12.571	-1.110	1.006	23.820	17.761	1.341	1.333	13.003	
-4.8	-7.0476	4.9311	64.9148	157.3686	12.769	-1.170	1.009	29.385	22.693	1.295	1.283	12.735	
-4.6	-6.8455	4.9057	64.4338	154.6220	12.967	-1.261	1.014	37.685	29.991	1.257	1.239	12.483	
-4.4	-6.6421	4.8873	63.7070	151.6445	13.184	-1.394	1.021	49.650	40.386	1.229	1.204	12.257	
-4.2	-6.4370	4.8106	62.6334	148.3415	13.358	-1.580	1.031	66.051	54.401	1.214	1.178	12.051	
-4.0	-6.2257	4.7298	61.1019	144.6123	13.550	-1.825	1.044	86.922	71.832	1.210	1.160	11.855	
-3.8	-6.0154	4.6197	59.0172	140.3742	13.739	-2.120	1.059	110.815	91.207	1.215	1.147	11.654	
-3.6	-5.8059	4.4783	56.3393	135.5999	13.922	-2.437	1.076	134.368	109.649	1.225	1.139	11.433	
-3.4	-5.5892	4.3088	53.1318	130.3684	14.100	-2.726	1.091	152.980	123.627	1.237	1.134	11.190	
-3.2	-5.3697	4.1201	49.5608	124.8556	14.272	-2.937	1.102	162.753	130.513	1.247	1.131	10.929	
-3.0	-5.1486	3.9245	45.8646	119.3074	14.438	-3.036	1.108	162.325	129.666	1.252	1.130	10.661	
-2.8	-4.9270	3.7340	42.2721	113.9515	14.598	-3.021	1.107	153.194	122.412	1.251	1.130	10.399	
-2.6	-4.7060	3.5575	38.5571	108.9582	14.752	-2.916	1.102	138.528	111.079	1.247	1.131	10.156	
-2.4	-4.4863	3.3957	36.0114	104.4114	14.903	-2.756	1.094	121.596	97.997	1.241	1.134	9.939	
-2.2	-4.2683	3.2617	33.4570	100.3240	15.049	-2.574	1.086	104.848	84.937	1.234	1.137	9.749	
-2.0	-4.0520	3.1421	31.2705	96.6635	15.193	-2.394	1.077	89.676	72.958	1.229	1.142	9.588	
-1.8	-3.8375	3.0388	29.4087	93.3792	15.333	-2.226	1.069	76.594	62.498	1.226	1.147	9.451	
-1.6	-3.6246	2.9495	27.8242	90.4163	15.469	-2.075	1.061	65.545	53.573	1.223	1.153	9.336	
-1.4	-3.4131	2.8724	26.4762	87.7232	15.601	-1.939	1.054	56.227	45.986	1.223	1.160	9.240	
-1.2	-3.2025	2.8060	25.3319	85.2767	15.729	-1.814	1.048	48.312	39.500	1.223	1.168	9.163	
-1.0	-2.9940	2.7492	24.3656	83.0317	15.853	-1.699	1.041	41.556	33.931	1.225	1.176	9.103	
-0.8	-2.7864	2.7011	23.5943	80.9658	15.972	-1.596	1.036	35.804	29.160	1.228	1.186	9.060	
-0.6	-2.5798	2.6605	22.8767	79.0538	16.089	-1.504	1.030	30.956	25.112	1.233	1.196	9.032	
-0.4	-2.3742	2.6264	22.3120	77.2720	16.202	-1.426	1.026	26.943	21.739	1.239	1.208	9.018	
-0.2	-2.1694	2.5976	21.8403	75.5977	16.313	-1.362	1.022	23.724	19.012	1.248	1.221	9.015	
0.	-1.9652	2.5729	21.4406	74.0075	16.422	-1.313	1.019	21.255	16.906	1.257	1.233	9.017	
0.2	-1.7615	2.5509	21.0923	72.4795	16.529	-1.281	1.018	19.540	15.428	1.267	1.244	9.019	
0.4	-1.5580	2.5302	20.7725	70.9897	16.634	-1.269	1.018	18.622	14.616	1.274	1.252	9.009	
0.6	-1.3543	2.5089	20.4552	69.5120	16.738	-1.282	1.019	18.607	14.560	1.278	1.254	8.978	
0.8	-1.1501	2.4848	20.1052	68.0160	16.841	-1.326	1.023	19.642	15.374	1.278	1.249	8.917	
1.0	-0.9445	2.4551	19.6964	66.4656	16.942	-1.408	1.030	21.921	17.197	1.275	1.238	8.825	
1.2	-0.7380	2.4164	19.1723	64.8194	17.042	-1.535	1.040	25.565	20.090	1.273	1.224	8.706	
1.4	-0.5287	2.3654	18.4917	63.0371	17.141	-1.709	1.053	30.467	23.908	1.274	1.210	8.564	
1.6	-0.3165	2.2955	17.6199	61.0905	17.238	-1.919	1.070	36.070	28.156	1.281	1.198	8.401	
1.8	-0.1008	2.2182	16.5509	58.9808	17.333	-2.135	1.086	41.297	31.993	1.291	1.188	8.218	
2.0	0.1179	2.1244	15.3217	56.7513	17.426	-2.315	1.100	44.844	34.502	1.300	1.181	8.019	
T = 10000 K													
-5.0	-7.2588	4.9567	64.3644	160.4024	12.563	-1.075	1.004	20.516	14.810	1.385	1.380	13.373	
-4.8	-7.0578	4.9452	64.1500	157.9078	12.762	-1.177	1.006	24.301	18.173	1.337	1.329	13.109	
-4.6	-6.8562	4.9274	63.8179	155.3020	12.960	-1.180	1.010	30.069	23.269	1.292	1.280	12.842	
-4.4	-6.6538	4.9000	63.3091	152.5101	13.158	-1.276	1.015	38.330	30.766	1.256	1.247	12.591	
-4.2	-6.4501	4.8588	62.5423	149.5155	13.354	-1.415	1.022	50.883	41.366	1.230	1.203	12.364	
-4.0	-6.2447	4.7993	61.4167	146.1654	13.548	-1.608	1.033	67.493	55.479	1.217	1.178	12.158	
-3.8	-6.0369	4.7126	59.8221	142.3800	13.740	-1.858	1.046	88.286	72.729	1.214	1.160	11.958	
-3.6	-5.8261	4.5969	57.6713	138.0644	13.927	-2.155	1.062	111.557	91.457	1.220	1.148	11.750	
-3.4	-5.6120	4.4502	54.9422	133.2714	14.110	-2.465	1.079	133.764	108.689	1.231	1.141	11.522	
-3.2	-5.3947	4.2765	51.7124	128.0313	14.287	-2.740	1.094	150.458	121.096	1.242	1.136	11.272	
-3.0	-5.1746	4.0854	48.1624	122.5549	14.458	-2.930	1.104	158.205	126.428	1.251	1.134	11.004	
-2.8	-4.9535	3.8896	44.5296	117.0959	14.622	-3.009	1.108	156.201	124.431	1.255	1.133	10.733	
-2.6	-4.7319	3.7006	41.0320	111.8410	14.781	-2.978	1.107	146.280	116.629	1.254	1.133	10.470	
-2.4	-4.5110	3.5266	37.8260	106.9716	14.935	-2.865	1.102	131.591	105.312	1.250	1.134	10.228	
-2.2	-4.2914	3.3715	34.9886	102.5454	15.084	-2.703	1.093	115.176	92.645	1.243	1.137	10.012	
-2.0	-4.0736	3.2361	32.5336	98.5707	15.229	-2.524	1.085	99.213	80.205	1.237	1.141	9.824	
-1.8	-3.8576	3.1188	30.4342	95.0088	15.371	-2.348	1.076	84.864	68.883	1.232	1.145	9.664	
-1.6	-3.6433	3.0176	28.6470	91.8091	15.510	-2.185	1.068	72.504	59.015	1.229	1.151	9.529	
-1.4	-3.4305	2.9302	27.1285	88.9217	15.644	-2.036	1.060	62.038	50.576	1.227	1.157	9.416	
-1.2	-3.2152	2.8550	25.8396	86.3011	15.775	-1.901	1.053	53.176	43.375	1.226	1.164	9.323	
-1.0	-3.0093	2.7905	24.7497	83.9117	15.901	-1.778	1.046	45.641	37.212	1.227	1.172	9.249	
-0.8	-2.8007	2.7357	23.8331	81.7231	16.023	-1.665	1.040	39.228	31.932	1.228	1.181	9.192	
-0.6	-2.5932	2.6893	23.0663	79.7074	16.142	-1.565	1.034	33.800	27.433	1.232	1.191	9.153	
-0.4	-2.3865	2.6504	22.4277	77.8397	16.257	-1.477	1.029	29.264	23.648	1.238	1.202	9.129	
-0.2	-2.1815	2.6177	21.8958	76.0949	16.369	-1.402	1.025	25.551	20.527	1.245	1.215	9.118	
0.	-1.9767	2.5900	21.4502	74.4504	16.479	-1.344	1.022	22.624	18.047	1.254	1.227	9.117	
0.2	-1.7728	2.5655	21.0658	72.8828	16.587	-1.300	1.019	20.439	16.182	1.263	1.239	9.119	
0.4	-1.5661	2.5441	20.7330	71.3695	16.694	-1.276	1.018	19.014	14.948	1.272	1.249	9.117	
0.6	-1.3655	2.5230	20.4157	69.8854	16.798	-1.273	1.019	18.413	14.401	1.279	1.255	9.101	
0.8	-1.1616	2.5004	20.0900	68.4030	16.902	-1.296	1.021	18.745	14.632	1.281	1.255	9.058	
1.0	-0.9570	2.4739	19.7222	66.9896	17.004	-1.353	1.026	20.179	15.765	1.280	1.248	8.984	
1.2	-0.7511	2.4405	19.2721	65.3076	17.105	-1.451	1.034	22.882	17.914	1.277	1.236	8.880	
1.4	-0.5432	2.3967	18.6943	63.6155	17.205	-1.595	1.045	26.899	21.067	1.277	1.221	8.749	
1.6	-0.3327	2.3393	17.9470	61.7771	17.303	-1.782	1.060	31.962	24.954	1.281	1.208	8.596	
1.8	-0.1185	2.2664	17.0060	59.7750	17.399	-1.994	1.077	37.317	28.947	1.289	1.197	8.422	
2.0	0.0981	2.1750	15.8822	57.6271	17.494	-2.196	1.093	41.779	32.165	1.299	1.188	8.228	

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T=10500 K												
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_0$	$\frac{T(\partial p)}{\rho(\partial T)_p}$	$\frac{p(\partial p)}{\rho(\partial p)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{\Lambda}{A_0}$
-5.0	-7.2810	4.9687	62.1646	161.2991	12.543	-1.031	1.002	16.578	11.302	1.467	1.464	14.134
-4.8	-7.0800	4.9637	62.0758	159.9132	12.742	-1.048	1.003	17.997	12.561	1.433	1.429	13.956
-4.6	-6.8799	4.9561	61.9389	156.4920	12.942	-1.074	1.004	20.282	14.586	1.391	1.385	13.727
-4.4	-6.6789	4.9442	61.7265	153.9998	13.141	-1.115	1.006	23.848	17.736	1.345	1.336	13.467
-4.2	-6.4773	4.9258	61.3981	151.3985	13.339	-1.178	1.010	29.284	22.512	1.301	1.288	13.198
-4.0	-6.2748	4.8976	60.8956	148.6336	13.536	-1.272	1.015	37.343	29.533	1.264	1.245	12.941
-3.8	-6.0710	4.8552	60.1400	145.6320	13.732	-1.409	1.023	48.842	39.420	1.239	1.211	12.707
-3.6	-5.8654	4.7931	59.0324	142.3016	13.927	-1.598	1.034	64.360	52.525	1.225	1.186	12.491
-3.4	-5.6574	4.7053	57.4690	138.9500	14.118	-1.841	1.047	83.656	68.425	1.223	1.167	12.282
-3.2	-5.4464	4.5875	55.3695	134.3101	14.305	-2.128	1.063	105.041	85.506	1.228	1.155	12.063
-3.0	-5.2320	4.4385	52.7148	129.5756	14.487	-2.425	1.080	125.202	101.034	1.239	1.147	11.825
-2.8	-5.0145	4.2629	49.5894	124.4457	14.664	-2.685	1.095	140.061	111.979	1.251	1.143	11.565
-2.6	-4.7945	4.0707	46.1697	119.1067	14.834	-2.863	1.105	146.624	116.416	1.259	1.140	11.288
-2.4	-4.5730	3.8741	42.6797	113.7872	14.998	-2.934	1.109	144.327	114.248	1.263	1.139	11.007
-2.2	-4.3512	3.6848	39.3280	108.6956	15.156	-2.903	1.108	134.955	106.920	1.262	1.139	10.737
-2.0	-4.1302	3.5105	36.2574	103.9689	15.309	-2.794	1.102	121.387	96.570	1.258	1.141	10.487
-1.8	-3.9105	3.3551	33.5356	99.6710	15.457	-2.640	1.094	106.347	84.974	1.252	1.144	10.265
-1.6	-3.6925	3.2122	31.1820	95.8043	15.601	-2.499	1.085	91.731	73.652	1.245	1.148	10.071
-1.4	-3.4764	3.1015	29.1733	92.3368	15.741	-2.399	1.076	78.542	63.317	1.240	1.152	9.906
-1.2	-3.2619	3.0002	27.4627	89.2220	15.877	-2.139	1.068	67.096	54.246	1.237	1.158	9.768
-1.0	-3.0492	2.9131	26.0145	86.4129	16.009	-1.992	1.060	57.332	46.432	1.235	1.165	9.653
-0.8	-2.8379	2.8387	24.7924	83.9658	16.136	-1.856	1.052	49.030	39.734	1.234	1.172	9.559
-0.6	-2.6281	2.7755	23.7662	81.5483	16.260	-1.734	1.045	41.988	34.010	1.235	1.181	9.487
-0.4	-2.4197	2.7221	22.9092	79.4258	16.380	-1.623	1.039	36.042	29.139	1.237	1.190	9.433
-0.2	-2.2125	2.6773	22.1964	77.4701	16.497	-1.526	1.033	31.069	25.034	1.241	1.201	9.397
0.	-2.0064	2.6357	21.6049	75.6566	16.610	-1.443	1.028	26.977	21.631	1.247	1.213	9.376
0.2	-1.8011	2.6081	21.1122	73.9536	16.721	-1.375	1.024	23.695	18.880	1.255	1.225	9.368
0.4	-1.5966	2.5811	20.6968	72.3435	16.830	-1.323	1.021	21.174	16.748	1.264	1.238	9.367
0.6	-1.3926	2.5572	20.3367	70.8004	16.937	-1.289	1.019	19.397	15.229	1.274	1.249	9.366
0.8	-1.1887	2.5348	20.0095	69.2997	17.043	-1.275	1.019	18.389	14.347	1.282	1.258	9.356
1.0	-0.9848	2.5119	19.6862	67.9153	17.147	-1.285	1.021	18.230	14.167	1.287	1.261	9.325
1.2	-0.7803	2.4861	19.3385	66.5167	17.250	-1.325	1.025	19.050	14.788	1.288	1.257	9.264
1.4	-0.5748	2.4586	18.9285	64.7637	17.351	-1.403	1.031	20.999	16.316	1.287	1.248	9.170
1.6	-0.3705	2.4339	18.4137	62.1324	17.452	-1.523	1.042	24.165	18.787	1.286	1.235	9.046
1.8	-0.1576	2.3607	17.7518	61.3706	17.551	-1.688	1.056	28.413	22.043	1.289	1.221	8.896
2.0	0.0549	2.2924	16.9119	59.4587	17.648	-1.884	1.072	33.220	25.632	1.296	1.209	8.723
T=11000 K												
-5.0	-7.3017	4.9740	60.0642	162.0313	12.523	-1.018	1.001	15.684	10.530	1.489	1.488	14.591
-4.8	-7.1015	4.9715	60.0170	159.5938	12.723	-1.024	1.001	16.022	10.810	1.481	1.479	14.543
-4.6	-6.9012	4.9679	59.9827	157.3415	12.922	-1.039	1.002	16.321	11.518	1.460	1.458	14.432
-4.4	-6.7037	4.9623	59.9565	155.9534	13.122	-1.052	1.003	18.243	12.772	1.428	1.424	14.258
-4.2	-6.4990	4.9538	59.7096	152.5240	13.321	-1.079	1.005	20.557	14.811	1.388	1.382	14.031
-4.0	-6.2968	4.9406	59.4829	150.0232	13.520	-1.123	1.007	24.176	17.988	1.344	1.334	13.771
-3.8	-6.0970	4.9202	59.1332	147.4024	13.718	-1.190	1.011	29.676	22.790	1.302	1.288	13.501
-3.6	-5.8942	4.8891	58.6005	144.6105	13.915	-1.289	1.017	37.780	29.796	1.268	1.247	13.242
-3.4	-5.6901	4.8425	57.9040	141.5724	14.111	-1.431	1.025	49.215	39.546	1.245	1.214	13.004
-3.2	-5.4840	4.7749	56.6460	138.1991	14.305	-1.624	1.036	64.386	52.229	1.233	1.189	12.781
-3.0	-5.2753	4.6804	55.0286	134.4037	14.495	-1.870	1.051	82.814	67.238	1.232	1.172	12.562
-2.8	-5.0635	4.5550	52.8835	130.1308	14.681	-2.152	1.067	102.586	82.829	1.239	1.160	12.331
-2.6	-4.8433	4.3569	50.2148	125.3932	14.862	-2.434	1.084	120.362	96.320	1.250	1.153	12.078
-2.4	-4.6301	4.2181	47.1247	120.3242	15.037	-2.670	1.098	132.486	105.085	1.261	1.148	11.804
-2.2	-4.4056	4.0231	43.7973	115.0939	15.206	-2.821	1.107	136.652	107.775	1.269	1.146	11.517
-2.0	-4.1878	3.8264	40.4482	109.7424	15.368	-2.868	1.110	132.898	104.533	1.271	1.145	11.228
-1.8	-3.9659	3.6387	37.2658	105.0417	15.524	-2.822	1.108	123.192	97.034	1.270	1.146	10.953
-1.6	-3.7450	3.4671	34.3722	100.5127	15.675	-2.707	1.102	110.213	87.144	1.265	1.148	10.700
-1.4	-3.5254	3.3147	31.8977	96.4025	15.821	-2.555	1.093	96.300	76.510	1.259	1.151	10.477
-1.2	-3.3077	3.1817	29.6209	92.7054	15.963	-2.389	1.084	82.984	66.242	1.253	1.155	10.283
-1.0	-3.0917	3.0669	27.7424	89.3888	16.100	-2.224	1.075	71.023	56.915	1.248	1.160	10.118
-0.8	-2.8775	2.9684	26.1512	86.4086	16.233	-2.068	1.067	60.033	48.726	1.244	1.167	9.981
-0.6	-2.6650	2.8842	24.8101	83.7204	16.362	-1.924	1.058	51.740	41.650	1.242	1.174	9.868
-0.4	-2.4541	2.8129	23.6860	81.2851	16.487	-1.792	1.051	44.189	35.588	1.242	1.182	9.779
-0.2	-2.2447	2.7527	22.7464	79.0663	16.608	-1.673	1.043	37.818	30.430	1.243	1.191	9.711
0.	-2.0367	2.7023	21.9703	77.0325	16.726	-1.569	1.037	32.492	26.081	1.246	1.201	9.653
0.2	-1.8299	2.6601	21.3258	75.1536	16.840	-1.478	1.031	28.100	22.465	1.251	1.213	9.603
0.4	-1.6241	2.6248	20.7915	73.4027	16.952	-1.403	1.027	24.554	19.520	1.258	1.225	9.617
0.6	-1.4191	2.5948	20.3441	71.7536	17.061	-1.344	1.023	21.787	17.203	1.266	1.238	9.611
0.8	-1.2147	2.5687	19.9611	70.1816	17.169	-1.303	1.021	19.761	15.489	1.276	1.250	9.609
1.0	-1.0106	2.5447	19.6195	68.6628	17.275	-1.281	1.020	18.481	14.386	1.285	1.259	9.601
1.2	-0.8065	2.5209	19.2935	67.1704	17.379	-1.282	1.021	17.996	13.937	1.291	1.265	9.576
1.4	-0.6021	2.4949	18.9938	65.6756	17.483	-1.312	1.024	18.409	14.219	1.295	1.264	9.524
1.6	-0.3966	2.4640	18.5654	64.1452	17.585	-1.375	1.030	19.848	15.325	1.295	1.257	9.439
1.8	-0.1897	2.4248	18.0933	62.5419	17.686	-1.480	1.040	22.608	17.301	1.295	1.245	9.320
2.0	0.0196	2.3737	17.4906	60.8289	17.785	-1.627	1.053	26.017	20.050	1.298	1.232	9.173

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$;
 $A_0 = 2.97804 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

$T=11500 \text{ K}$												
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_e$	$\frac{T(\partial p)}{\rho(\partial T)_p}$	$\frac{p(\partial p)}{\rho(\partial p)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$
-5.0	-7.2214	4.9783	58.1512	162.7454	12.504	-1.024	1.001	16.822	11.609	1.449	1.448	14.721
-4.8	-7.1212	4.9760	58.1013	160.4033	12.704	-1.021	1.001	16.204	11.026	1.470	1.468	14.823
-4.6	-6.9210	4.9736	58.0538	158.0649	12.904	-1.022	1.001	16.074	10.887	1.477	1.475	14.852
-4.4	-6.7207	4.9706	57.9984	155.7200	13.103	-1.028	1.002	16.401	11.158	1.470	1.468	14.811
-4.2	-6.5203	4.9662	57.9232	153.3566	13.303	-1.039	1.002	17.250	11.897	1.450	1.447	14.698
-4.0	-6.3197	4.9556	57.8126	150.9599	13.502	-1.059	1.004	18.788	13.245	1.418	1.413	14.520
-3.8	-6.1189	4.9456	57.6649	148.5109	13.702	-1.091	1.005	21.297	15.440	1.379	1.372	14.290
-3.6	-5.9175	4.9335	57.3865	145.9763	13.900	-1.140	1.008	25.216	18.858	1.337	1.326	14.026
-3.4	-5.7154	4.9099	56.9906	143.3134	14.098	-1.215	1.013	31.122	23.972	1.298	1.282	13.756
-3.2	-5.5121	4.8736	56.3915	140.4612	14.295	-1.324	1.020	39.708	31.325	1.268	1.243	13.498
-3.0	-5.3073	4.8197	55.5041	137.3407	14.490	-1.479	1.029	51.587	41.339	1.248	1.213	13.257
-2.8	-5.1003	4.7424	54.2320	133.8661	14.682	-1.685	1.042	66.883	53.949	1.240	1.190	13.029
-2.6	-4.8905	4.6365	52.4867	129.9602	14.871	-1.938	1.057	84.701	68.226	1.241	1.175	12.797
-2.4	-4.6774	4.4950	50.2242	125.5928	15.055	-2.215	1.074	102.724	82.174	1.250	1.164	12.550
-2.2	-4.4610	4.3223	47.4821	120.8161	15.234	-2.476	1.090	117.592	93.215	1.262	1.158	12.280
-2.0	-4.2417	4.1441	44.3914	115.7730	15.407	-2.678	1.102	126.218	95.249	1.272	1.156	11.991
-1.8	-4.0205	3.9463	41.1474	110.6660	15.573	-2.789	1.109	127.247	95.577	1.279	1.152	11.692
-1.6	-3.7984	3.7508	37.9531	105.6997	15.732	-2.801	1.110	121.478	94.974	1.279	1.152	11.399
-1.4	-3.5766	3.5673	34.5681	101.0303	15.886	-2.731	1.107	111.097	87.057	1.276	1.153	11.122
-1.2	-3.3555	3.4013	32.2865	96.7448	16.034	-2.605	1.100	98.527	77.534	1.271	1.155	10.871
-1.0	-3.1368	3.2550	29.9426	92.8690	16.177	-2.451	1.091	85.664	67.738	1.265	1.159	10.651
-0.8	-2.9196	3.1279	27.9296	89.3873	16.316	-2.289	1.082	73.633	58.487	1.259	1.164	10.463
-0.6	-2.7041	3.0187	26.2198	86.2627	16.450	-2.129	1.073	62.929	50.170	1.254	1.169	10.304
-0.4	-2.4905	2.9255	24.7738	83.4535	16.580	-1.979	1.064	53.661	42.893	1.251	1.176	10.172
-0.2	-2.2786	2.8466	23.5721	80.9183	16.705	-1.840	1.055	45.754	36.622	1.249	1.184	10.067
0.0	-2.0664	2.7801	22.5671	78.6182	16.827	-1.714	1.047	39.073	31.276	1.249	1.193	9.986
0.2	-1.8596	2.7245	21.7342	76.5183	16.945	-1.603	1.040	33.492	26.764	1.251	1.203	9.927
0.4	-1.6521	2.6781	21.0460	74.5863	17.060	-1.507	1.034	28.885	23.008	1.255	1.214	9.887
0.6	-1.4458	2.6354	20.4769	72.7931	17.173	-1.426	1.029	25.155	19.940	1.262	1.226	9.864
0.8	-1.2404	2.6066	20.0027	71.1111	17.283	-1.362	1.025	22.222	17.504	1.270	1.238	9.852
1.0	-1.0356	2.5783	19.6000	69.5147	17.390	-1.316	1.022	20.034	15.669	1.279	1.251	9.847
1.2	-0.8313	2.5527	19.2452	67.9786	17.497	-1.289	1.021	18.578	14.428	1.288	1.261	9.838
1.4	-0.6270	2.5277	18.9130	66.4766	17.602	-1.284	1.022	17.686	13.809	1.295	1.268	9.816
1.6	-0.4224	2.5010	18.5745	64.9800	17.705	-1.306	1.025	18.037	13.874	1.300	1.269	9.769
1.8	-0.2178	2.4695	18.1964	63.4871	17.807	-1.361	1.030	19.160	14.999	1.302	1.264	9.689
2.0	-0.0100	2.4308	17.7398	61.8717	17.909	-1.455	1.039	21.282	16.330	1.303	1.254	9.573
$T=12000 \text{ K}$												
-5.0	-7.3405	4.9560	56.5036	163.5367	12.486	-1.055	1.002	21.110	15.570	1.356	1.353	14.549
-4.8	-7.1402	4.9818	56.3994	161.1362	12.686	-1.038	1.002	16.751	13.401	1.400	1.398	14.782
-4.6	-6.9396	4.9786	56.3235	158.7681	12.886	-1.029	1.001	17.356	12.095	1.435	1.433	14.963
-4.4	-6.7396	4.9758	56.2634	156.4156	13.085	-1.025	1.001	16.648	11.428	1.457	1.455	15.072
-4.2	-6.5394	4.9728	56.2058	154.0673	13.285	-1.026	1.001	16.501	11.270	1.464	1.462	15.105
-4.0	-6.3390	4.9690	56.1389	151.7117	13.485	-1.034	1.002	16.883	11.585	1.457	1.454	15.060
-3.8	-6.1396	4.9635	56.0477	149.3330	13.684	-1.048	1.003	17.875	12.443	1.437	1.432	14.936
-3.6	-5.9378	4.9552	55.9341	146.9155	13.884	-1.082	1.004	19.661	13.997	1.405	1.398	14.746
-3.4	-5.7367	4.9426	55.7714	144.4336	14.082	-1.110	1.007	22.558	16.515	1.366	1.357	14.505
-3.2	-5.5350	4.9231	55.4013	141.9516	14.281	-1.168	1.011	27.028	20.381	1.326	1.312	14.238
-3.0	-5.3324	4.8934	54.9289	139.1193	14.478	-1.256	1.016	33.679	26.085	1.291	1.271	13.969
-2.8	-5.1284	4.8489	54.2215	136.1670	14.674	-1.383	1.024	43.140	34.090	1.265	1.236	13.712
-2.6	-4.9226	4.7840	53.1900	132.9169	14.868	-1.557	1.035	55.807	44.606	1.251	1.209	13.471
-2.4	-4.7142	4.6927	51.7408	129.2844	15.058	-1.780	1.049	71.391	57.222	1.248	1.189	13.233
-2.2	-4.5028	4.5707	49.8050	125.2140	15.245	-2.039	1.065	88.402	70.563	1.253	1.176	12.986
-2.0	-4.2880	4.4176	47.3766	120.7147	15.427	-2.305	1.082	104.104	82.414	1.263	1.162	12.720
-1.8	-4.0700	4.2384	44.5371	115.8812	15.602	-2.535	1.097	115.312	90.480	1.274	1.162	12.431
-1.6	-3.8495	4.0431	41.4489	110.8800	15.771	-2.690	1.107	119.845	93.412	1.283	1.159	12.126
-1.4	-3.6276	3.9441	38.3103	105.9313	15.934	-2.751	1.111	117.463	91.285	1.287	1.158	11.819
-1.2	-3.4054	3.8526	35.3023	101.1977	16.090	-2.722	1.110	109.678	85.292	1.286	1.159	11.523
-1.0	-3.1939	3.4761	32.5474	96.8019	16.240	-2.626	1.105	98.733	77.036	1.282	1.160	11.250
-0.8	-2.9637	3.3186	30.1082	92.7996	16.385	-2.488	1.097	86.681	67.946	1.276	1.163	11.007
-0.6	-2.7453	3.1810	27.9979	89.1928	16.525	-2.332	1.087	74.915	59.008	1.270	1.168	10.796
-0.4	-2.5289	3.0625	26.1988	85.9571	16.660	-2.173	1.078	64.184	50.771	1.264	1.173	10.617
-0.2	-2.3143	2.9612	24.6804	83.0522	16.790	-2.019	1.068	54.753	43.457	1.260	1.179	10.469
0.0	-2.1015	2.8755	23.4054	80.4378	16.916	-1.875	1.059	46.652	37.107	1.257	1.187	10.349
0.2	-1.8905	2.8035	22.3523	78.0735	17.038	-1.744	1.051	39.792	31.674	1.256	1.196	10.255
0.4	-1.6811	2.7424	21.4776	75.9222	17.157	-1.628	1.043	34.055	27.085	1.257	1.205	10.185
0.6	-1.4731	2.6932	20.7560	73.9450	17.272	-1.528	1.037	29.322	23.261	1.261	1.216	10.137
0.8	-1.2663	2.6515	20.1606	72.1232	17.385	-1.443	1.031	25.486	20.132	1.266	1.228	10.106
1.0	-1.0605	2.6153	19.6660	70.4160	17.495	-1.376	1.027	22.461	17.639	1.273	1.240	10.089
1.2	-0.8554	2.5860	19.2479	68.8002	17.603	-1.326	1.024	20.183	15.743	1.282	1.252	10.080
1.4	-0.6508	2.5587	18.8822	67.2499	17.710	-1.295	1.022	18.630	14.430	1.291	1.263	10.069
1.6	-0.4463	2.5324	18.5433	65.7398	17.815	-1.287	1.023	17.820	13.717	1.299	1.270	10.047
1.8	-0.2415	2.5047	18.2027	64.2381	17.918	-1.305	1.025	17.815	13.653	1.305	1.272	10.000
2.0	-0.0359	2.4726	17.9173	62.7155	18.021	-1.356	1.031	18.710	14.302	1.308	1.269	9.922

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING
MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; p₀ = 1.01325 × 10⁵ N/m²; ρ₀ = 1.59842 kg/m³; R = 8.31469 J/mole-°K;

A₀ = 2.97904 × 10³ m/sec; and M_u = 35.838]

T=12500 K												
log ₁₀ p/p ₀	log ₁₀ ρ/ρ ₀	Z	H RT	g R	log ₁₀ N _e	T(θp) ρ(θp) _T	p(θp) ρ(θp) _T	C _p R	C _v R	γ	γ _E	A A ₀
-5.0	-7.2599	5.0043	55.2681	164.5806	12.470	-1.136	1.005	31.447	25.022	1.257	1.250	14.300
-4.8	-7.1590	4.9941	55.0102	162.0210	12.669	-1.091	1.004	25.580	19.656	1.301	1.297	14.549
-4.6	-6.9584	4.9871	54.8379	159.5508	12.869	-1.061	1.003	21.676	16.071	1.349	1.345	14.809
-4.4	-6.7575	4.9822	54.7202	157.1371	13.068	-1.043	1.002	19.200	13.792	1.392	1.390	15.043
-4.2	-6.5576	4.9785	54.6354	154.7592	13.268	-1.033	1.002	17.741	12.438	1.426	1.424	15.224
-4.0	-6.3573	4.9750	54.5655	152.3973	13.468	-1.030	1.002	17.042	11.777	1.447	1.445	15.329
-3.8	-6.1570	4.9712	54.4960	150.0373	13.667	-1.032	1.002	16.968	11.681	1.453	1.450	15.350
-3.6	-5.9565	4.9663	54.4129	147.6663	13.867	-1.042	1.003	17.510	12.132	1.443	1.440	15.287
-3.4	-5.7559	4.9591	54.2985	145.2665	14.066	-1.060	1.004	18.760	13.207	1.420	1.415	15.145
-3.2	-5.5550	4.9493	54.1266	142.9163	14.265	-1.091	1.006	20.959	15.108	1.387	1.379	14.936
-3.0	-5.3535	4.9317	53.8735	140.2848	14.464	-1.138	1.009	25.468	18.135	1.349	1.337	14.682
-2.8	-5.1513	4.9064	53.4837	137.6293	14.661	-1.211	1.014	29.795	22.697	1.313	1.295	14.411
-2.6	-4.9479	4.8681	52.8961	134.7902	14.858	-1.318	1.021	37.535	29.254	1.283	1.257	14.143
-2.4	-4.7426	4.8117	52.0302	131.6950	15.053	-1.468	1.030	48.176	38.117	1.264	1.227	13.889
-2.2	-4.5355	4.7311	50.7938	128.2598	15.245	-1.666	1.043	61.762	49.181	1.256	1.204	13.643
-2.0	-4.3253	4.6212	49.1083	124.4200	15.433	-1.906	1.059	77.366	61.516	1.258	1.187	13.393
-1.8	-4.1117	4.4795	46.9385	120.1533	15.617	-2.166	1.076	92.853	73.328	1.266	1.177	13.126
-1.6	-3.8949	4.3050	44.3284	115.5185	15.795	-2.408	1.092	105.268	82.396	1.278	1.170	12.837
-1.4	-3.6752	4.1178	41.4081	110.6574	15.966	-2.591	1.104	112.060	87.034	1.288	1.166	12.528
-1.2	-3.4536	3.9179	38.3623	105.7612	16.131	-2.587	1.111	112.260	86.794	1.293	1.164	12.211
-1.0	-3.2312	3.7213	35.3778	101.0180	16.289	-2.693	1.112	106.722	82.448	1.294	1.164	11.900
-0.8	-3.0092	3.5372	32.5981	96.5675	16.441	-2.623	1.108	97.381	75.410	1.291	1.166	11.609
-0.6	-2.7883	3.3710	30.1074	92.4871	16.587	-2.503	1.101	86.292	67.106	1.286	1.168	11.346
-0.4	-2.5660	3.2247	27.9351	88.7967	16.727	-2.355	1.092	75.006	58.618	1.280	1.172	11.115
-0.2	-2.3516	3.0983	26.0755	85.4825	16.863	-2.199	1.082	64.453	50.608	1.274	1.177	10.918
0.	-2.1362	2.9903	24.5048	82.5102	16.994	-2.044	1.072	55.046	43.392	1.269	1.183	10.754
0.2	-1.9227	2.8999	22.1896	79.8395	17.120	-1.898	1.063	46.902	37.077	1.265	1.190	10.621
0.4	-1.7111	2.8222	22.0968	77.4299	17.243	-1.764	1.054	39.938	31.653	1.263	1.199	10.516
0.6	-1.5011	2.7583	21.1955	75.2425	17.362	-1.644	1.046	34.196	27.064	1.264	1.208	10.437
0.8	-1.2927	2.7051	20.4593	73.2413	17.477	-1.541	1.039	29.424	23.241	1.266	1.219	10.380
1.0	-1.0855	2.6608	19.8377	71.3935	17.590	-1.454	1.033	25.557	20.112	1.271	1.230	10.344
1.2	-0.8794	2.6235	19.3257	69.6691	17.700	-1.384	1.028	22.506	17.617	1.277	1.242	10.321
1.4	-0.6741	2.5915	18.9012	68.0399	17.808	-1.333	1.025	20.203	15.713	1.286	1.254	10.307
1.6	-0.4692	2.5628	18.5276	66.4766	17.915	-1.301	1.024	18.618	14.381	1.295	1.265	10.293
1.8	-0.2645	2.5351	18.1827	64.9609	18.019	-1.291	1.024	17.761	13.633	1.303	1.272	10.268
2.0	-0.0595	2.5059	17.8378	63.4551	18.123	-1.308	1.027	17.683	13.507	1.309	1.275	10.220
T=13000 K												
-5.0	-7.2804	5.0452	54.6961	162.1625	12.457	-1.294	1.012	50.975	42.632	1.196	1.182	14.236
-4.8	-7.1784	5.0219	54.1222	163.2712	12.655	-1.206	1.008	39.723	32.483	1.223	1.213	14.389
-4.6	-6.9770	5.0058	53.7275	160.5679	12.853	-1.140	1.006	31.408	24.939	1.259	1.252	14.598
-4.4	-6.7751	4.9949	53.4616	157.9993	13.052	-1.094	1.004	25.618	19.680	1.303	1.298	14.846
-4.2	-6.5754	4.9874	53.2826	155.5222	13.252	-1.064	1.003	21.775	16.142	1.349	1.345	15.103
-4.0	-6.3749	4.9820	53.1597	153.1028	13.451	-1.046	1.002	19.362	13.923	1.391	1.388	15.331
-3.8	-6.1746	4.9776	53.0657	150.7151	13.651	-1.037	1.002	17.989	12.651	1.422	1.419	15.498
-3.6	-5.9742	4.9734	52.9859	148.3455	13.850	-1.035	1.002	17.409	12.092	1.440	1.437	15.586
-3.4	-5.7738	4.9685	52.9013	145.9713	14.050	-1.040	1.002	17.523	12.159	1.441	1.438	15.583
-3.2	-5.5732	4.9618	52.7955	143.5790	14.249	-1.054	1.003	18.343	12.849	1.428	1.423	15.491
-3.0	-5.3723	4.9521	52.6465	141.1476	14.449	-1.079	1.005	20.025	14.288	1.401	1.394	15.320
-2.8	-5.1710	4.9373	52.4239	138.6453	14.647	-1.119	1.008	22.863	16.727	1.367	1.356	15.087
-2.6	-4.9690	4.9148	52.0878	136.0419	14.845	-1.182	1.012	27.270	20.491	1.331	1.315	14.822
-2.4	-4.7660	4.8867	51.5807	133.2790	15.042	-1.274	1.018	33.786	26.002	1.299	1.276	14.549
-2.2	-4.5615	4.8500	50.8276	130.2892	15.237	-1.407	1.027	42.925	33.621	1.277	1.243	14.284
-2.0	-4.3546	4.7956	49.7415	126.9945	15.430	-1.585	1.039	54.890	43.389	1.265	1.217	14.029
-1.8	-4.1455	4.6556	48.2355	123.3242	15.620	-1.808	1.054	69.111	54.680	1.264	1.199	13.773
-1.6	-3.9329	4.5223	46.2768	119.2408	15.805	-2.058	1.071	83.917	66.040	1.271	1.186	13.504
-1.4	-3.7170	4.3595	43.8532	114.7767	15.984	-2.302	1.088	96.666	75.430	1.282	1.178	13.212
-1.2	-3.4979	4.1725	41.0901	110.0484	16.158	-2.501	1.102	104.728	81.043	1.292	1.173	12.899
-1.0	-3.2767	3.9731	38.1495	105.2320	16.324	-2.622	1.110	106.691	82.096	1.300	1.171	12.574
-0.8	-3.0543	3.7734	35.2165	100.5154	16.484	-2.653	1.113	102.892	79.024	1.302	1.170	12.251
-0.6	-2.8319	3.5838	32.4472	96.0526	16.637	-2.606	1.110	94.944	73.028	1.300	1.171	11.944
-0.4	-2.6104	3.4110	29.9400	91.3355	16.784	-2.501	1.104	84.807	65.480	1.295	1.173	11.664
-0.2	-2.3905	3.2581	27.7392	86.2000	16.925	-2.362	1.095	74.699	57.494	1.289	1.177	11.417
0.	-2.1725	3.1254	25.8483	84.8399	17.061	-2.210	1.085	63.857	49.797	1.282	1.182	11.204
0.2	-1.9564	3.0120	24.2484	81.8276	17.192	-2.056	1.075	54.616	42.778	1.277	1.187	11.027
0.4	-1.7424	2.9162	22.9054	79.1243	17.319	-1.908	1.065	46.559	36.590	1.272	1.194	10.981
0.6	-1.5302	2.8358	21.7579	76.6890	17.441	-1.773	1.056	39.696	31.257	1.270	1.202	10.967
0.8	-1.3175	2.7689	20.8807	74.4813	17.560	-1.652	1.048	33.950	26.741	1.270	1.212	10.960
1.0	-1.1110	2.7133	20.1263	72.4653	17.675	-1.547	1.040	29.218	22.980	1.271	1.222	10.917
1.2	-0.9036	2.6671	19.5057	70.6063	17.788	-1.459	1.034	25.391	19.905	1.276	1.233	10.874
1.4	-0.6972	2.6282	18.9914	68.8727	17.898	-1.388	1.030	22.376	17.457	1.282	1.245	10.847
1.6	-0.4916	2.5948	18.5578	67.2368	18.006	-1.336	1.026	20.105	15.590	1.290	1.257	10.828
1.8	-0.2866	2.5646	18.1792	65.6703	18.112	-1.305	1.025	18.543	14.284	1.298	1.267	10.809
2.0	-0.0816	2.5355	17.8255	64.1464	18.217	-1.296	1.025	17.699	13.548	1.306	1.274	10.780

TABLE III.- NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Continued

[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole-}^\circ\text{K}$; $A_0 = 2.97904 \times 10^3 \text{ m/sec}$; and $M_u = 35.828$]

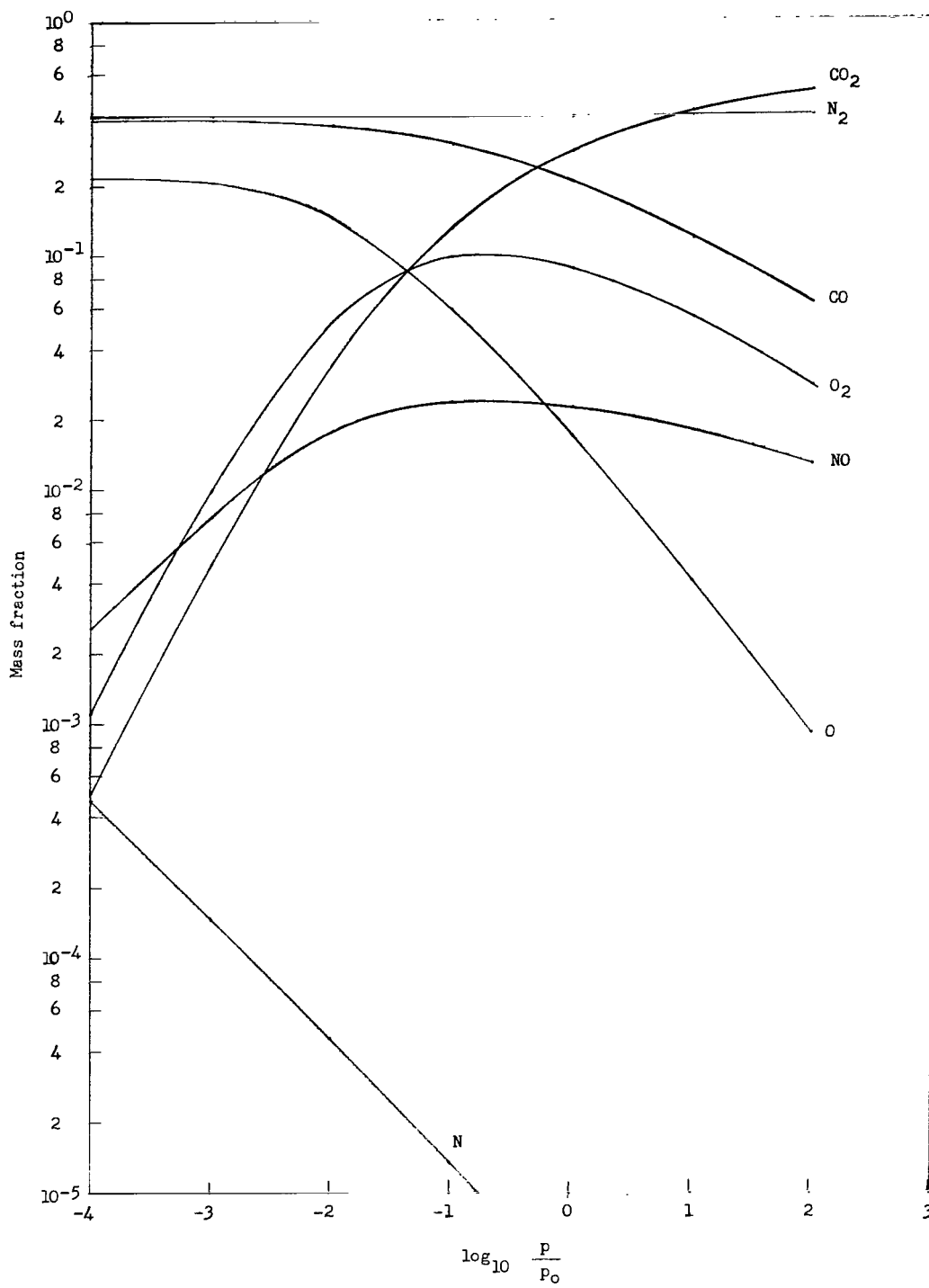
T=13500 K													
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{S}{R}$	$\log_{10} N_0$	$\frac{T(\partial p)}{\rho(\partial T)_p}$	$\frac{p(\partial p)}{\rho(\partial p)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$	$\frac{A}{A_0}$
-5.0	-7.4033	5.1217	55.0435	168.5772	12.446	-1.509	1.021	77.768	66.341	1.172	1.148	14.407	14.407
-4.8	-7.1906	5.0777	53.9862	165.1722	12.643	-1.392	1.016	62.412	52.731	1.184	1.165	14.448	14.448
-4.6	-6.9968	5.0450	53.2003	162.0561	12.840	-1.286	1.012	48.956	40.714	1.202	1.188	14.547	14.547
-4.4	-6.7548	5.0216	52.6421	159.1803	13.038	-1.200	1.008	36.289	31.119	1.230	1.220	14.707	14.707
-4.2	-6.5924	5.0054	52.2563	156.4878	13.237	-1.136	1.006	30.455	24.030	1.267	1.260	14.922	14.922
-4.0	-6.3924	4.9943	51.9991	153.9267	13.436	-1.093	1.004	25.040	19.103	1.311	1.306	15.172	15.172
-3.8	-6.1917	4.9866	51.8220	151.4513	13.635	-1.064	1.003	21.488	15.858	1.355	1.351	15.422	15.422
-3.6	-5.9912	4.9808	51.6963	149.0306	13.835	-1.048	1.002	19.310	13.856	1.394	1.390	15.636	15.636
-3.4	-5.7908	4.9758	51.5972	146.6390	14.034	-1.041	1.002	18.157	12.780	1.421	1.418	15.780	15.780
-3.2	-5.5903	4.9705	51.5046	144.2562	14.234	-1.042	1.003	17.832	12.448	1.432	1.429	15.835	15.835
-3.0	-5.3898	4.9640	51.3991	141.8631	14.433	-1.052	1.003	18.264	12.789	1.428	1.423	15.793	15.793
-2.8	-5.1890	4.9547	51.2595	139.4396	14.632	-1.073	1.005	19.541	13.869	1.409	1.402	15.661	15.661
-2.6	-4.9877	4.9410	51.0576	136.9588	14.831	-1.108	1.007	21.880	15.862	1.379	1.369	15.454	15.454
-2.4	-4.7855	4.9202	50.7557	134.3860	15.029	-1.163	1.011	25.032	19.053	1.345	1.330	15.201	15.201
-2.2	-4.5831	4.8887	50.3005	131.6717	15.226	-1.246	1.017	31.285	23.824	1.313	1.291	14.928	14.928
-2.0	-4.3785	4.8417	49.6232	128.7530	15.422	-1.366	1.025	39.329	30.521	1.289	1.257	14.656	14.656
-1.8	-4.1728	4.7734	48.6407	125.5557	15.615	-1.530	1.037	50.035	39.261	1.274	1.229	14.392	14.392
-1.6	-3.9640	4.6779	47.2685	122.0060	15.806	-1.738	1.051	63.058	49.617	1.271	1.209	14.129	14.129
-1.4	-3.7521	4.5512	45.4491	118.0603	15.992	-1.978	1.068	77.037	60.369	1.276	1.195	13.855	13.855
-1.2	-3.5367	4.3533	43.1837	113.7343	16.172	-2.220	1.085	89.623	69.670	1.286	1.185	13.559	13.559
-1.0	-3.3182	4.2056	40.5548	109.1237	16.347	-2.426	1.100	98.243	75.721	1.297	1.180	13.241	13.241
-0.8	-3.0972	4.0108	37.7162	104.3919	16.515	-2.561	1.109	101.266	77.558	1.306	1.177	12.909	12.909
-0.6	-2.8746	3.8093	34.8490	99.7262	16.675	-2.640	1.113	98.680	75.373	1.309	1.176	12.575	12.575
-0.4	-2.6522	3.6160	32.1133	95.2792	16.829	-2.579	1.112	91.817	70.191	1.308	1.176	12.255	12.255
-0.2	-2.4303	3.4385	29.6181	91.1604	16.977	-2.486	1.106	82.518	63.301	1.304	1.179	11.961	11.961
0.	-2.2095	3.2807	27.4164	87.4124	17.118	-2.356	1.098	72.393	55.807	1.297	1.182	11.699	11.699
0.2	-1.9913	3.1435	25.5198	84.0371	17.254	-2.207	1.088	62.545	48.470	1.290	1.186	11.474	11.474
0.4	-1.7748	3.0262	23.9143	81.0121	17.385	-2.055	1.077	53.571	41.713	1.284	1.192	11.285	11.285
0.6	-1.5604	2.9271	22.5706	78.2982	17.512	-1.908	1.067	45.702	35.722	1.279	1.199	11.130	11.130
0.8	-1.3475	2.8442	21.4566	75.9560	17.634	-1.772	1.058	38.989	30.548	1.276	1.207	11.007	11.007
1.0	-1.1372	2.7752	20.5385	73.6445	17.752	-1.650	1.049	33.370	26.166	1.275	1.216	10.913	10.913
1.2	-0.9282	2.7180	19.7846	71.6261	17.867	-1.545	1.042	28.750	22.520	1.277	1.226	10.845	10.845
1.4	-0.7205	2.6704	19.1645	69.7656	17.980	-1.458	1.035	25.025	19.546	1.280	1.237	10.797	10.797
1.6	-0.5135	2.6303	18.6506	68.0315	18.090	-1.388	1.031	22.102	17.185	1.286	1.248	10.765	10.765
1.8	-0.3082	2.5957	18.2165	66.3942	18.197	-1.337	1.027	19.912	15.395	1.293	1.259	10.741	10.741
2.0	-0.1029	2.5643	17.8361	64.8257	18.303	-1.307	1.026	18.422	14.153	1.302	1.269	10.717	10.717
T=14000 K													
-5.0	-7.4288	5.2366	56.3229	171.8792	12.440	-1.702	1.030	103.079	88.337	1.167	1.133	14.741	14.741
-4.8	-7.2233	5.1705	54.7557	167.9160	12.635	-1.602	1.026	88.508	75.571	1.171	1.142	14.703	14.703
-4.6	-7.0186	5.1156	53.4666	164.2592	12.830	-1.486	1.021	73.024	61.964	1.178	1.155	14.705	14.705
-4.4	-6.8150	5.0728	52.4666	160.9140	13.027	-1.369	1.016	58.245	48.907	1.191	1.173	14.758	14.758
-4.2	-6.6123	5.0412	51.7308	157.8497	13.224	-1.267	1.011	45.683	37.691	1.212	1.198	14.871	14.871
-4.0	-6.4103	5.0187	51.2120	155.0149	13.422	-1.186	1.008	35.905	28.907	1.242	1.232	15.046	15.046
-3.8	-6.2050	5.0032	50.8560	152.3513	13.621	-1.127	1.006	28.846	22.530	1.280	1.273	15.272	15.272
-3.6	-6.0060	4.9924	50.6136	149.8075	13.820	-1.087	1.004	24.038	18.162	1.323	1.318	15.523	15.523
-3.4	-5.8074	4.9847	50.4451	147.3417	14.019	-1.062	1.003	20.954	15.347	1.365	1.361	15.761	15.761
-3.2	-5.6068	4.9784	50.3197	144.9224	14.219	-1.049	1.003	19.162	13.695	1.399	1.396	15.949	15.949
-3.0	-5.4063	4.9725	50.2125	142.5242	14.418	-1.046	1.003	18.367	12.938	1.420	1.416	16.054	16.054
-2.8	-5.2057	4.9657	50.1014	140.1246	14.618	-1.053	1.003	18.429	12.945	1.424	1.419	16.060	16.060
-2.6	-5.0049	4.9566	49.9860	137.7023	14.817	-1.070	1.005	19.363	13.716	1.412	1.405	15.967	15.967
-2.4	-4.8037	4.9433	49.7727	135.2314	15.016	-1.101	1.007	21.322	15.370	1.387	1.377	15.789	15.789
-2.2	-4.6020	4.9234	49.4905	132.6768	15.214	-1.151	1.011	24.610	18.152	1.356	1.341	15.549	15.549
-2.0	-4.3953	4.8933	49.0681	129.9938	15.411	-1.228	1.016	29.643	22.382	1.324	1.303	15.279	15.279
-1.8	-4.1953	4.8483	48.4393	127.1211	15.607	-1.340	1.024	36.901	28.408	1.299	1.268	15.003	15.003
-1.6	-3.9894	4.7828	47.5244	123.9975	15.801	-1.493	1.035	46.667	36.366	1.283	1.239	14.732	14.732
-1.4	-3.7810	4.6907	46.2405	120.5212	15.991	-1.691	1.050	58.708	45.929	1.278	1.218	14.462	14.462
-1.2	-3.5694	4.5676	44.5258	116.6735	16.178	-1.922	1.066	71.873	56.049	1.282	1.203	14.181	14.181
-1.0	-3.3544	4.4126	42.3724	112.4509	16.359	-2.159	1.083	84.031	65.039	1.292	1.193	13.880	13.880
-0.8	-3.1362	4.2312	39.8512	107.9387	16.534	-2.367	1.099	92.722	71.150	1.303	1.186	13.556	13.556
-0.6	-2.9152	4.0325	37.1038	103.2879	16.703	-2.509	1.109	96.243	73.359	1.312	1.183	13.215	13.215
-0.4	-2.6929	3.8300	34.3065	98.6801	16.864	-2.568	1.114	94.387	71.715	1.316	1.182	12.871	12.871
-0.2	-2.4701	3.6343	31.6203	94.2758	17.018	-2.547	1.113	88.291	67.113	1.316	1.182	12.540	12.540
0.	-2.2480	3.4537	29.1583	90.1825	17.166	-2.463	1.108	79.666	60.756	1.311	1.184	12.234	12.234
0.2	-2.0273	3.2926	26.9755	86.4510	17.307	-2.338	1.099	70.089	53.717	1.305	1.187	11.961	11.961
0.4	-1.8064	3.1525	25.1003	83.0886	17.443	-2.193	1.089	60.665	46.749	1.298	1.191	11.725	11.725
0.6	-1.5916	3.0327	23.5090	80.0739	17.574	-2.043	1.079	52.022	40.294	1.291	1.197	11.527	11.527
0.8	-1.3768	2.9317	22.1788	77.3711	17.700	-1.897	1.068	44.424	34.553	1.286	1.203	11.364	11.364
1.0	-1.1642	2.8472	21.0773	74.9396	17.822	-1.762	1.059	37.938	29.591	1.282	1.211	11.235	11.235
1.2	-0.9553	2.7771	20.1708	72.7385	17.939	-1.641	1.050	32.518	25.391	1.282	1.220	11.136	11.136
1.4	-0.7441	2.7150	19.4272	70.7298	18.054	-1.537	1.042	28.072	21.905	1.282	1.230	11.063	11.063
1.6	-0.5365	2.6707	18.8157	68.8776	18.166	-1.451	1.036	24.502	19.071	1.285	1.240	11.011	11.011
1.8	-0.3257	2.6259	18.3082	67.1498	18.276	-1.384	1.031	21.717	16.834	1.290	1.251	10.975	10.975
2.0	-0.1236	2.5943	17.8778	65.5167	18.383	-1.335	1.028	19.652	15.152	1.297	1.261	10.946	10.946

TABLE III. - NONDIMENSIONAL THERMODYNAMIC PROPERTIES FOR THE NASA ENGINEERING

MARS ATMOSPHERE MODEL 3, THE "MINIMUM" MODEL - Concluded

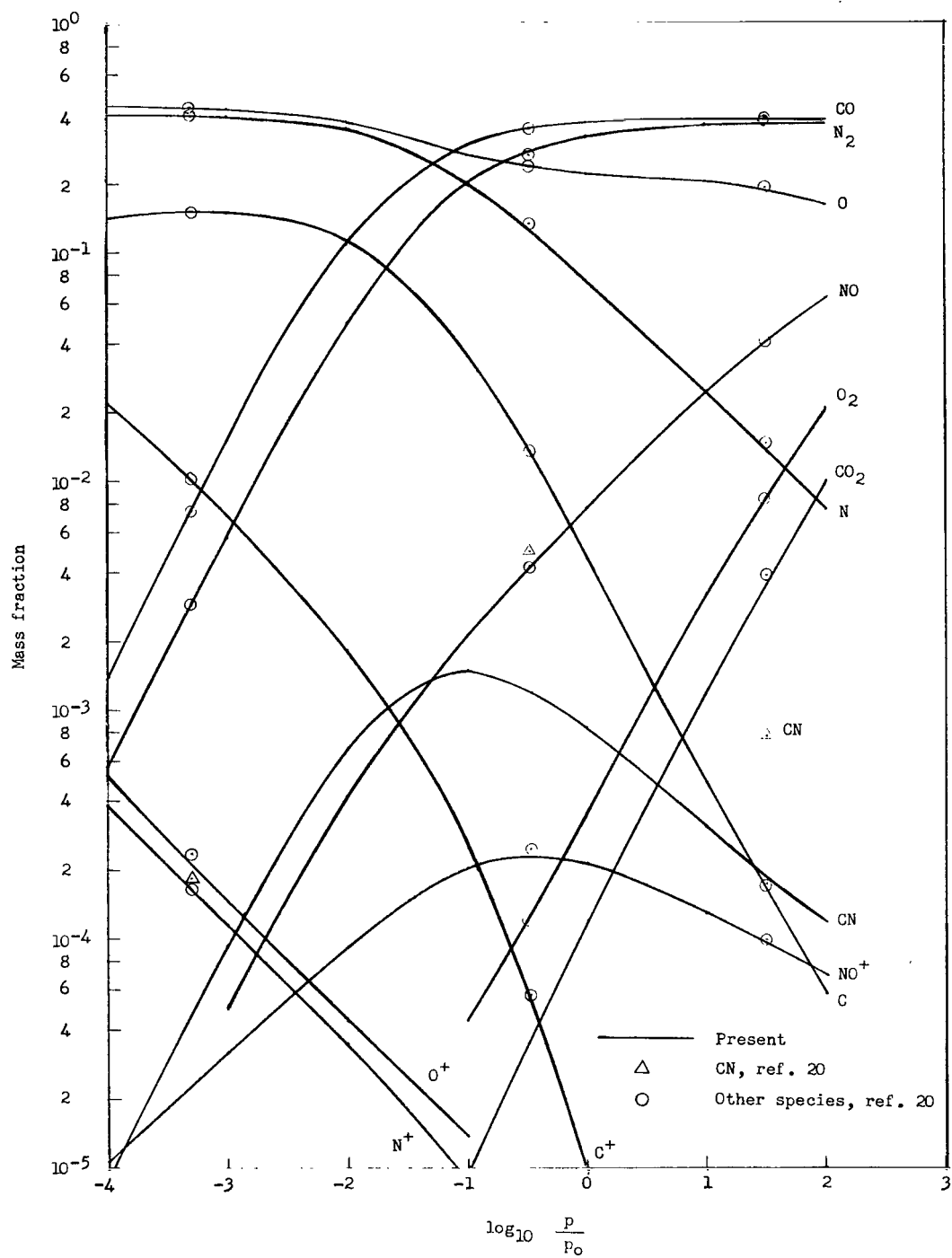
[60% CO₂, 40% N₂ by mass; $p_0 = 1.01325 \times 10^5 \text{ N/m}^2$; $\rho_0 = 1.59842 \text{ kg/m}^3$; $R = 8.31469 \text{ J/mole} \cdot ^\circ\text{K}$; $A_0 = 2.97904 \times 10^2 \text{ m/sec}$; and $M_u = 35.828$]

T=14500 K													
$\log_{10} p/p_0$	$\log_{10} \rho/\rho_0$	Z	$\frac{H}{RT}$	$\frac{g}{R}$	$\log_{10} N_e$	$\frac{T(\theta p)}{p(\theta p)_T}$	$\frac{p(\theta p)}{p(\theta p)_T}$	$\frac{C_p}{R}$	$\frac{C_v}{R}$	γ	γ_E	$\frac{A}{A_0}$	$\frac{u}{u_0}$
-5.0	-7.4555	5.3813	58.3155	175.8816	12.435	-1.849	1.036	125.351	107.593	1.165	1.125	15.151	
-4.8	-7.2490	5.2971	56.3250	171.4325	12.629	-1.770	1.033	111.430	95.368	1.168	1.131	15.074	
-4.6	-7.0428	5.2216	54.5681	167.2538	12.823	-1.678	1.029	97.320	83.035	1.172	1.139	15.015	
-4.4	-6.8373	5.1567	53.0757	163.3718	13.018	-1.568	1.025	82.185	69.817	1.177	1.149	14.987	
-4.2	-6.6329	5.1041	51.8758	159.8104	13.214	-1.448	1.020	66.917	56.417	1.186	1.163	15.004	
-4.0	-6.4294	5.0639	50.9620	156.5556	13.411	-1.335	1.015	53.020	44.132	1.201	1.184	15.077	
-3.8	-6.2269	5.0345	50.2999	153.5688	13.608	-1.239	1.011	41.593	33.949	1.225	1.212	15.213	
-3.6	-6.0251	5.0139	49.8370	150.7924	13.807	-1.165	1.007	32.965	26.206	1.258	1.249	15.407	
-3.4	-5.8239	4.9995	49.5196	148.1696	14.005	-1.114	1.005	26.878	20.710	1.298	1.291	15.644	
-3.2	-5.6230	4.9893	49.3005	145.6504	14.204	-1.080	1.004	22.838	17.044	1.340	1.335	15.891	
-3.0	-5.4223	4.9815	49.1425	143.1968	14.404	-1.060	1.003	20.359	14.776	1.378	1.374	16.107	
-2.8	-5.2217	4.9746	49.0156	140.7778	14.603	-1.053	1.003	19.075	13.579	1.405	1.401	16.253	
-2.6	-5.0211	4.9672	48.8939	138.3669	14.802	-1.056	1.004	18.777	13.260	1.416	1.411	16.302	
-2.4	-4.8203	4.9578	48.7530	135.9404	15.002	-1.070	1.005	19.405	13.755	1.411	1.404	16.246	
-2.2	-4.6191	4.9445	48.5643	133.4713	15.200	-1.098	1.007	21.067	15.144	1.391	1.381	16.093	
-2.0	-4.4174	4.9248	48.2918	130.9262	15.399	-1.145	1.011	24.011	17.617	1.363	1.349	15.870	
-1.8	-4.2147	4.8952	47.8868	128.2593	15.596	-1.218	1.016	28.619	21.472	1.333	1.312	15.605	
-1.6	-4.0108	4.8510	47.2857	125.4135	15.792	-1.324	1.024	35.324	27.015	1.308	1.277	15.326	
-1.4	-3.8050	4.7865	46.4109	122.3186	15.986	-1.472	1.035	44.406	34.388	1.291	1.248	15.049	
-1.2	-3.5967	4.6957	45.1809	118.9041	16.176	-1.662	1.049	55.681	43.315	1.286	1.226	14.772	
-1.0	-3.3853	4.5739	43.5336	115.1211	16.363	-1.886	1.066	68.100	52.834	1.289	1.210	14.484	
-0.8	-3.1704	4.4202	41.4576	110.9731	16.545	-2.118	1.083	79.692	61.379	1.298	1.199	14.176	
-0.6	-2.9522	4.2352	39.0174	106.5383	16.720	-2.323	1.098	88.121	67.291	1.310	1.192	13.844	
-0.4	-2.7314	4.0404	36.3470	101.9607	16.889	-2.466	1.109	91.707	69.556	1.318	1.189	13.494	
-0.2	-2.5089	3.8367	33.6193	97.4194	17.050	-2.529	1.114	90.177	68.163	1.323	1.187	13.141	
0.	-2.2860	3.6394	30.9923	93.0715	17.204	-2.512	1.114	84.549	63.930	1.323	1.187	12.800	
0.2	-2.0637	3.4570	28.5799	89.0257	17.352	-2.432	1.109	76.429	57.982	1.318	1.189	12.484	
0.4	-1.8427	3.2943	26.4439	85.3359	17.493	-2.311	1.100	67.338	51.344	1.312	1.192	12.202	
0.6	-1.6237	3.1528	24.6017	82.0102	17.628	-2.169	1.090	58.346	44.743	1.304	1.196	11.958	
0.8	-1.4067	3.0319	23.0430	79.0282	17.758	-2.021	1.079	50.083	38.615	1.297	1.201	11.753	
1.0	-1.1919	2.9302	21.7420	76.3551	17.884	-1.877	1.069	42.816	33.161	1.291	1.208	11.585	
1.2	-0.9791	2.8454	20.6666	73.9505	18.005	-1.744	1.059	36.620	28.451	1.287	1.215	11.452	
1.4	-0.7682	2.7750	19.7827	71.7730	18.122	-1.625	1.050	31.456	24.474	1.285	1.224	11.349	
1.6	-0.5590	2.7167	19.0581	69.7843	18.236	-1.524	1.042	27.237	21.183	1.286	1.233	11.272	
1.8	-0.3512	2.6681	18.4619	67.9485	18.347	-1.441	1.036	23.866	18.521	1.289	1.244	11.216	
2.0	-0.1444	2.6268	17.9657	66.2333	18.456	-1.377	1.032	21.260	16.435	1.294	1.254	11.175	
T=15000 K													
-5.0	-7.4843	5.5538	61.0036	180.5895	12.432	-2.024	1.042	154.216	132.396	1.165	1.117	15.602	
-4.8	-7.2761	5.4507	58.5434	175.5964	12.625	-1.922	1.039	135.251	115.877	1.167	1.123	15.498	
-4.6	-7.0686	5.3573	56.3611	170.9254	12.818	-1.833	1.036	119.403	102.027	1.170	1.130	15.407	
-4.4	-6.8618	5.2731	54.4305	166.5474	13.012	-1.743	1.033	104.824	89.312	1.174	1.137	15.332	
-4.2	-6.6556	5.1992	52.7620	162.4681	13.207	-1.638	1.028	89.888	76.318	1.178	1.145	15.283	
-4.0	-6.4504	5.1374	51.3873	158.7090	13.402	-1.520	1.023	74.511	62.912	1.184	1.157	15.211	
-3.8	-6.2463	5.0866	50.3006	155.2730	13.598	-1.400	1.018	59.828	50.032	1.194	1.175	15.311	
-3.6	-6.0432	5.0521	49.4462	152.1342	13.795	-1.293	1.013	47.140	38.811	1.215	1.199	15.412	
-3.4	-5.8409	5.0259	48.9225	149.2401	13.993	-1.206	1.009	37.144	29.902	1.242	1.231	15.575	
-3.2	-5.6393	5.0076	48.5247	146.5326	14.191	-1.143	1.007	29.843	23.348	1.278	1.270	15.792	
-3.0	-5.4382	4.9945	48.2497	143.9543	14.390	-1.099	1.005	24.851	18.843	1.319	1.313	16.036	
-2.8	-5.2373	4.9848	48.0546	141.4615	14.589	-1.073	1.004	21.678	15.958	1.358	1.353	16.267	
-2.6	-5.0366	4.9767	47.9038	139.0174	14.789	-1.061	1.003	19.900	14.318	1.390	1.385	16.443	
-2.4	-4.8359	4.9685	47.7676	136.5912	14.988	-1.061	1.004	19.247	13.680	1.407	1.401	16.527	
-2.2	-4.6350	4.9585	47.6186	134.1562	15.187	-1.072	1.005	19.606	13.932	1.407	1.400	16.503	
-2.0	-4.4338	4.9448	47.4268	131.6838	15.386	-1.099	1.007	21.034	15.107	1.392	1.382	16.375	
-1.8	-4.2321	4.9248	47.1558	129.1402	15.584	-1.144	1.011	23.736	17.359	1.367	1.353	16.166	
-1.6	-4.0294	4.8948	46.7565	126.4793	15.781	-1.214	1.016	28.057	20.952	1.339	1.318	15.907	
-1.4	-3.8255	4.8502	46.1662	123.6442	15.977	-1.318	1.024	34.388	26.160	1.315	1.284	15.627	
-1.2	-3.6196	4.7853	45.3089	120.5673	16.171	-1.462	1.035	42.992	33.111	1.298	1.254	15.345	
-1.0	-3.4112	4.6938	44.1048	117.1794	16.362	-1.648	1.049	53.677	41.527	1.293	1.232	15.060	
-0.8	-3.1997	4.5713	42.4936	113.4336	16.548	-1.867	1.066	65.435	50.493	1.296	1.216	14.765	
-0.6	-2.9848	4.4167	40.4646	109.3340	16.730	-2.093	1.083	76.388	58.522	1.305	1.205	14.448	
-0.4	-2.7665	4.2347	38.0807	104.9571	16.905	-2.293	1.099	84.317	64.052	1.316	1.198	14.106	
-0.2	-2.5455	4.0350	35.4744	100.4460	17.073	-2.433	1.110	87.641	66.130	1.325	1.194	13.747	
0.	-2.3229	3.8303	32.8136	95.9743	17.234	-2.493	1.115	86.109	64.760	1.330	1.192	13.384	
0.2	-2.0995	3.6323	30.2535	91.6966	17.388	-2.476	1.115	80.701	60.720	1.329	1.193	13.035	
0.4	-1.8774	3.4454	27.9044	87.7173	17.535	-2.397	1.109	72.942	55.075	1.324	1.194	12.711	
0.6	-1.6564	3.2864	25.8272	84.0899	17.675	-2.277	1.101	64.272	48.788	1.317	1.197	12.422	
0.8	-1.4373	3.1449	24.0387	80.8214	17.810	-2.137	1.090	55.711	42.545	1.309	1.201	12.172	
1.0	-1.2203	3.0244	22.5284	77.8916	17.939	-1.991	1.079	47.860	36.758	1.302	1.206	11.963	
1.2	-1.0055	2.9231	21.2703	75.2647	18.063	-1.849	1.069	40.970	31.619	1.296	1.213	11.791	
1.4	-0.7928	2.8388	20.2321	72.9003	18.183	-1.719	1.059	35.114	27.191	1.291	1.220	11.655	
1.6	-0.5820	2.7690	19.3801	70.7575	18.300	-1.604	1.050	30.251	23.466	1.289	1.228	11.549	
1.8	-0.3728	2.7112	18.6819	68.7979	18.413	-1.506	1.042	26.299	20.397	1.289	1.237	11.470	
2.0	-0.1650	2.6628	18.1066	66.9855	18.524	-1.427	1.036	23.165	17.931	1.292	1.247	11.411	



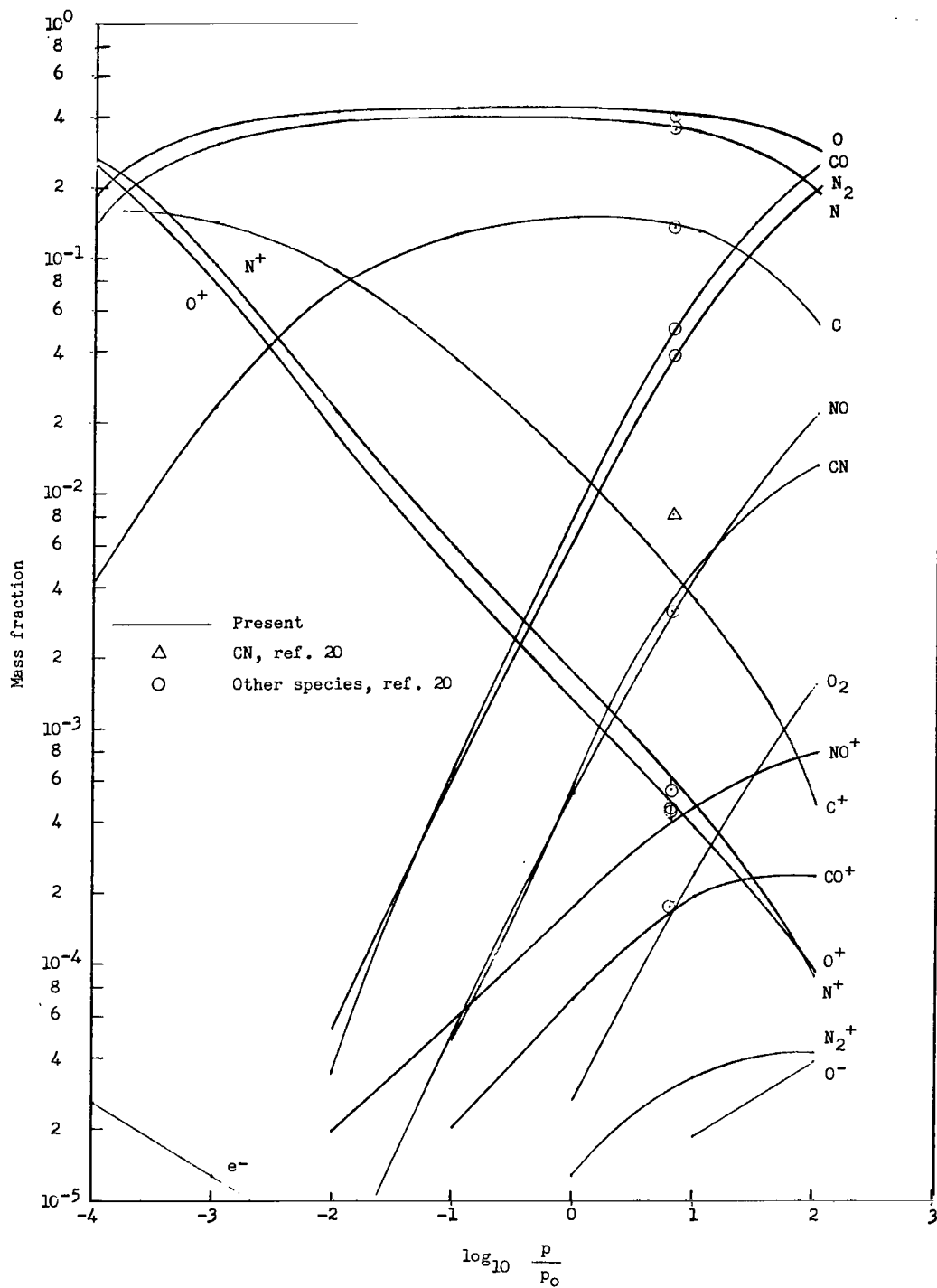
(a) $T = 3000^\circ \text{ K}$.

Figure 1.- Variation of species concentration with pressure.



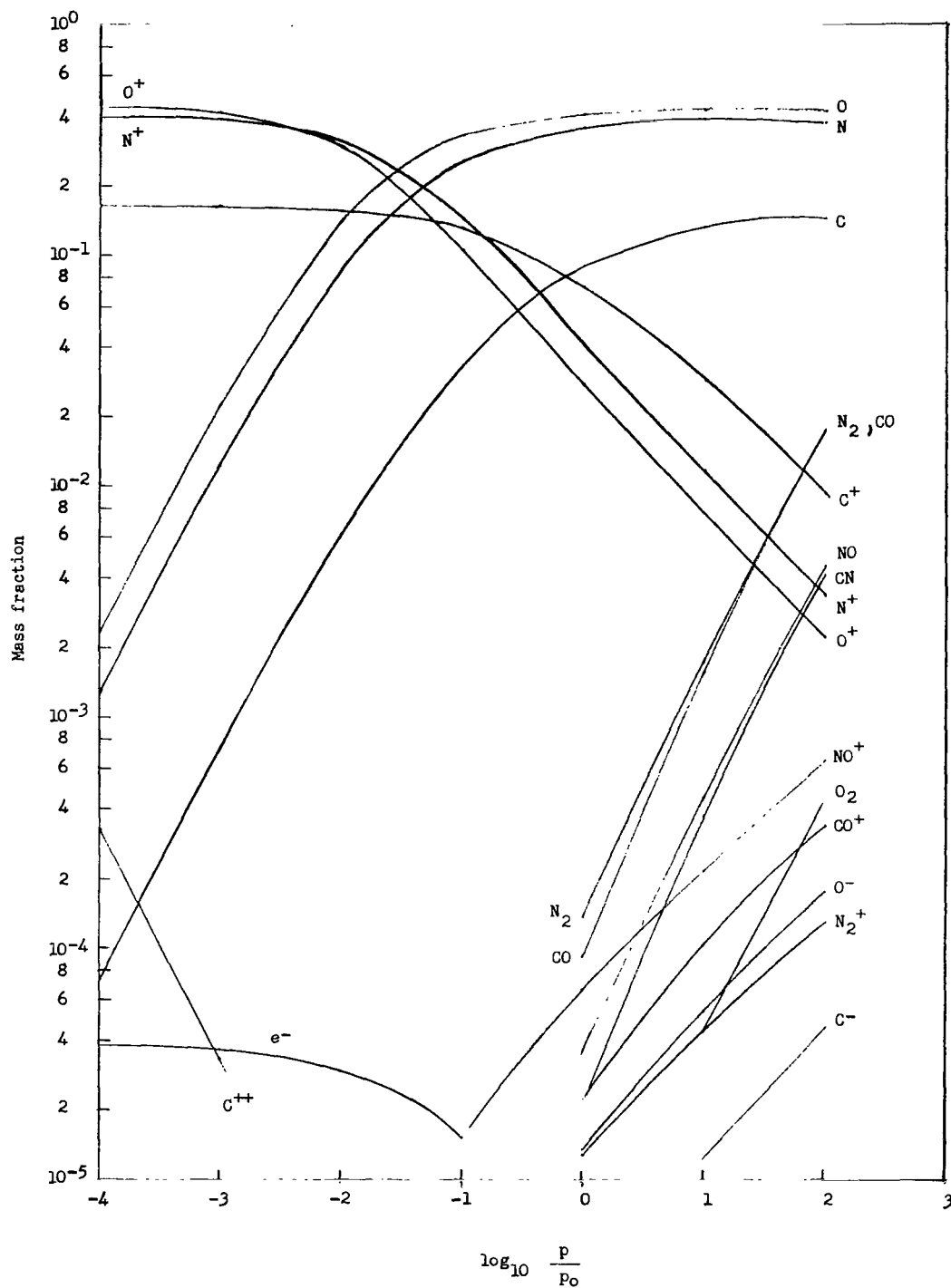
(b) $T = 6000^\circ \text{K}$.

Figure 1.- Continued.



(c) $T = 9000^\circ \text{K.}$

Figure 1.- Continued.



(d) $T = 12,000^\circ \text{K}$.

Figure 1.- Concluded.

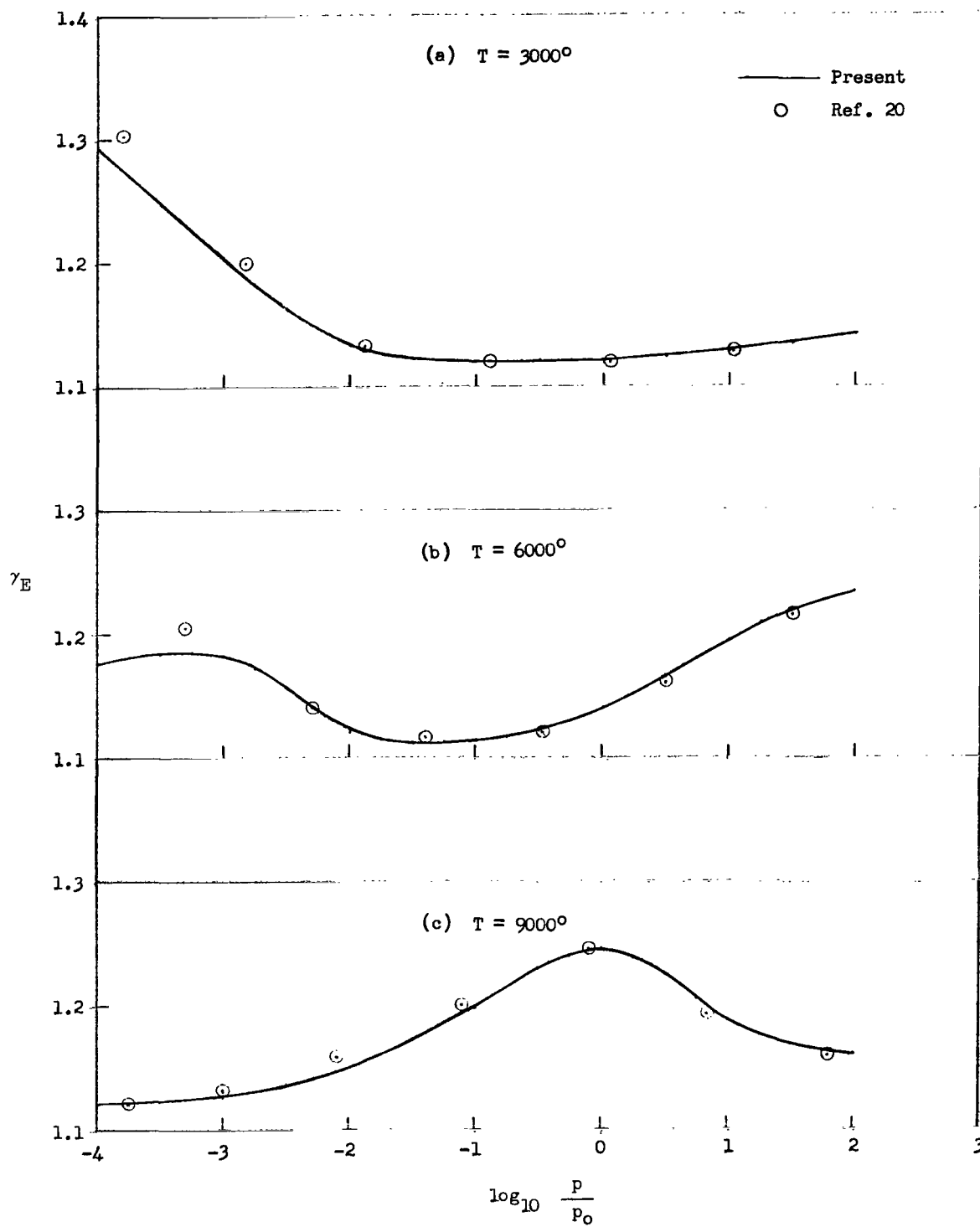


Figure 2.- Variation of isentropic exponent with pressure.

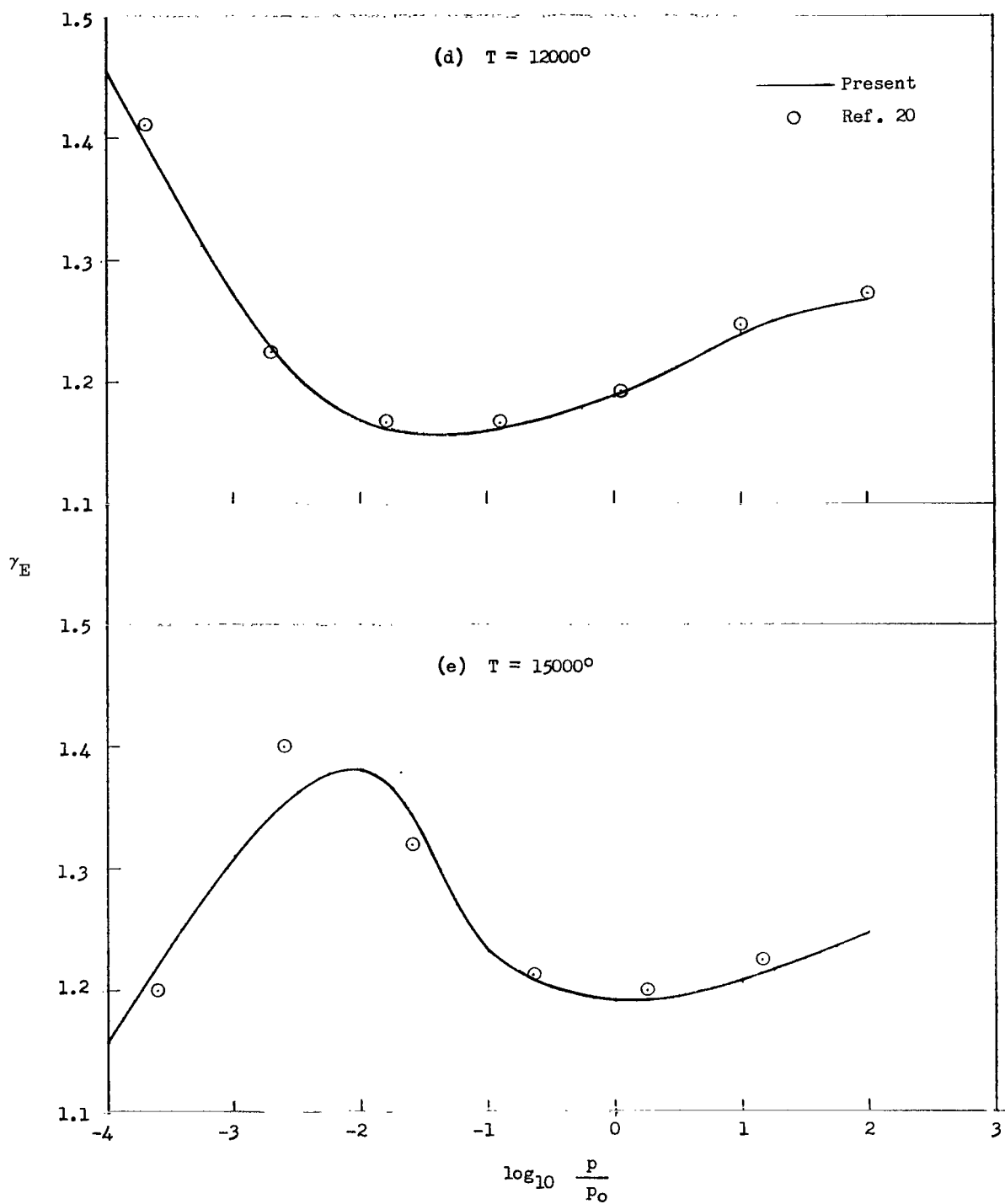


Figure 2.- Concluded.

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